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A
COLLECTION.

Of SCARCE and VALUABLE

TREATISES,

UPON

METALS, MINES, *and* MINERALS.

In Four PARTS.

PART I. and II.

Containing the Art of METALS, Written originally in *Spanish*. By the learned ALBARO ALONSO BARBA, Director of the Mines at *Potosi*, in the *Spanish West-Indies*. Translated by the Earl of SANDWICH, in the Year 1669.

PART III.

Containing that Invaluable PIECE of Mr G. PLATTES, *viz.* a Discovery of all Sorts of Mines from Gold to Coal.

PART IV.

HOUGHTON'S Compleat MINER.

L O N D O N,

Printed by C. Jephson, in *West-Smithfield*,
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THE

PREFACE

THOU hast now in thy Hands a Jewel so much esteemed in Spain and the Indies, that there they sell even all they have (and the Kingdom of Heaven to boot) to purchase it; for having this, they think that therewith they shall have all Things (in this World I mean) given unto them: And in that Country, I must tell you, it will go a great Way toward the Purchase of the other. Indeed there are some in all Nations that will sell that they have not, nor ever shall have; but this was a Jewel so rare, that few had it to sell, for it was concealed like the great Arcanum, the Philosopher's Stone, and only traditionally delivered to the Adepti; but it falling into the Hands of this true Nobleman of England, he not envying the rest of Mankind so great a Benefit, nor being willing so great a Treasure should be wrapt up in a Napkin, he honoured
and

P R E F A C E, &c.

and enriched our Language with it, being contented that all our Lord the King's People should be Philosophers.

Advertisement concerning the present Edition.

HAVING for some Years observed a great Demand for Books of this Kind (and for these Treatises in particular) which, by the judicious, are esteemed as good, or better than any on the Subject, (and very rare) and finding nothing new published, was induced to the present Undertaking; I am informed by a Gentleman of undoubted Credit, that the Sale of Barba's Book is prohibited in Spain, under the Penalty of the Inquisition, and is so scarce in England, that I am informed there is but one Copy of the Spanish Edition, which is in Sir Hans Sloan's Library; Plattes's Discovery is very much esteemed, as being founded upon Experience: Also Houghton is valuable for his Laws relating to Mines, and his Explanation of the Miners Terms, &c.

O. PAYNE.

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T H E.



TREATISE

OF

METALS MINES, &c.

CHAP. I.

*Of the Companions of Metals; and first
of the Earth, and the several Colours
thereof.*



ALL the inanimate Things
within the Bowels of the
Earth are reducible into one
of these four Kinds of
Mixtures, viz. METALS,
STONES, EARTH, or
JUICES.

Nature produces These mingled one with
the other; and because the Art of separating of
Metals cannot be put in practice without un-
derstanding the Nature of the other three,

B

(as

(as will hereafter appear) therefore I shall treat of These a little.

By the word *Earth* I do not mean that pure and simple Element, whereof the Philosophers say all mixed sublunary Bodies are composed.

Neither do I mean that which is so gross as it remains mixed with Metal, Vitriol, or other Juices.

But I mean such an earthy Substance as neither melts in the Fire, nor dissolves in the Water, as Metals and Juices do, nor is so compacted or hard as are Stones.

Some report *Aristotle* to have been of Opinion, that the pure elementary Earth was void of Colour. *Strabo* affirms it to be white, because Ashes are of that Colour; but the Miner may rest secure, that, dig he never so deep, he shall not meet with any such pure Element of Earth to make new Experiments by, because it is not in the World, by Reason of the perpetual Mixture of the Elements one with the other.

The Colour of the purest Earth that hath been found, *Cardona* would have to be a very dark Grey: In the other sorts of Earth we see how rich Nature hath adorned the World with Variety of Colours, caused by difference of Exhalation, as *Theophrastus* says, or by difference of Heat, as *Aristotle* says, and both truly: For if under Earth, that hath not it's natural and proper Colour, there be found Metals, it is certain, that the Exhalations from those Metals hath discoloured the Ground; and if there be no Metal found there, then the Discolouring proceeds from the

con-

consuming Power of the Sun's Heat. Besides, the Discolouring that comes by reason of Exhalation carries a Glistering and Shining along with it, and the Discolouring from the Sun's over-concoction only is obscure, or iron-colour'd, or black.

From what is already said, considerable Conjectures may be made for the finding out of Mines in the Bowels of the Earth, by the Colour of the Ground and Cliffs, or by the Tilth ploughed up upon the Mountains; as daily Experience hath shewn all over the Dominions of *Spain*.

CHAP. II.

Of the divers Smells of the Earth, and the Reason thereof.

THE Works of Nature in producing Variety of Smells of Earth, is also worthy of Admiration.

Ordinarily the Earth smells well upon the Fall of the first Rains after the Heat of Summer is past: The dry Time having baked together the moderate Humidity that was in the Earth, (which is the Cause from whence all good Smells proceed) and the first Rains dissolving that again (which being exhaled by moderate Heat) makes the good Scent which we perceive. Some Sorts of earthen Vessels also have this Privilege, as that of *Estremoz* in *Portugal*, and of *Nata* in *Panama*, which

are highly esteemed in *Europe* for that Quality. In the famous City of *Malacca*, in the *East-Indies*, they say there is a Sort of earthen Vessel that smells admirably, in so great abundance, that it is little esteemed, and they make all their most servile Sort of Ware of it: And in some Mines good smelling Earth hath been met withal, although most commonly that kind of Earth is of an ill Scent. *Agricola* relates, that when *Henry* Prince of *Saxony* was in *Marienburg*, there came so sweet a Smell out of the Mine, which they called *St Sebastian*, that the Prince admired thereat, and said, that he thought he was in *Calivet*, that famous Country of the *Indies*, which for it's rare Smells and other Excellencies hath been thought by judicious Men to be the Paradise wherein *Adam* of old, and the Fathers now enjoy God upon Earth. The Metal that comes out of the Mines which they call *Palos* is of a good Smell, if they light not upon some bastard Mineral that accompanies, and has infected it: And this good Smell is a great Sign of the Richness of the Stones of that Mine, and of the Earth which they get there called *Lampos*, This Experiment is ordinary in Lead or Tin Mines; and it is usual for the Miners to judge of their Oar by the Smell, as well as by the Taste. Other Sorts of Metal for the most part have an ill Smell, either because of their own natural Distemper, or by reason of their being generally mixed with Brimstone, Copperas, or other malignant Juices.

Some do think, that, over and above what hath been said, there is some Matter in the Bowels

Bowels of the Earth so stinking and abominable, that it doth correspond with the Ordure of Animals: The Truth is, that there be Places in the Earth that instantly kill, with a pestilential Smell. And setting aside the Stories of this Kind, both ancient and modern in remote Countries, I shall relate two Examples, where I myself was present, which was at the Discovery of the rich Country of *San Christoval de los Lipes*; at that Time in a beautiful high Hill, that together with others encompassed the Dwelling of the Miners, two *Galleguares* found a Mine, which at first they called after their own Names, but ever since, to this present, it is called, from it's Effects, *The stinking Mine*. At first they got out of it very rich Oar (*Tacana*) between white Chalk: And as they began to sink deeper, they were forced to give over, by reason of a most abominable ill Smell they met withal, which killed several of the Miners. *Indians*; and so it lay unwrought for four or five Years: After which Time another Miner (I being then in the Country) undertook to proceed in the working of it; thinking that having lain still so long after it's first Opening, the ill Quality would have been evaporated; but that Experiment cost the Lives of two *Indians* more, whereupon they forbore the Work, and have done so unto this Day. The which I have not so much wondered at, as to see with my Eyes the Ground opened in several other Parts of that Mountain, at a great Distance from the forementioned Mine, and in digging scarce a Yard deep, such a Stink came out of the Ground as forced the Labourers

fourers to give over : And as I passed by those Pits a few Days after, I saw divers Birds and Serpents dead in them, having been intoxicated by that poisonous Smell : On the other side of this forbidden Hill (until Divine Providence make way for the Mining of the same) are built Dwelling-houses, and a Mill to grind Metals withal, adjoining unto a marshy Ground ; which in every Place where they digg'd to lay the shallow Foundations of those Buildings, the same Smell breaks out, as hath been already described ; and it comes out of the Ground boiling like unto a Cellar full of Wine on the Must ; exceeding troublesome and noisome unto us, though we were standing by in the open Air.

In the famous Country of Mines, *Verenguela de Pacages*, in which the *Indians* procured a Patent to dig, before that of *Potosi* was in use, because it's Veins were esteemed much richer than *Potosi*, and upon Trial were found to be so ; and the Oar gotten there inferior to none in the *Indies*. In the Hill of that Country called *Sancta Juanna*, a Miner followed a very rich and plentiful Vein of Silver, and intending to discover more of the like, he determined to break a Hole into an old Vault *, and set two *Indians* upon the Work, who after a few Blows discovered a Vacuity, out of which came so pestilential a Stink, that killed the two *Indians* presently, and almost stifled others that were at a Distance

* An usual Practice among the Miners in that Country.

stance from them in the Mine, who nevertheless ran out, and told their Master what had happened. He made haste to the Mine, hoping to save the *Indians*, but at first Entrance into the Ground, upon the Stairs by which they went down into the Mine, he fell down dead, and his Body remained there, no Body daring to go down and take it away to bury it,

In another Mine in the same Mountain, in the Bottom of it, I saw a thick Exhalation or poisonous Vapour gush forth, making a terrible Noise, and was of Quality bad enough to kill one that would stay long in that Mine, putting out the Candles when we held them to it, which is a certain Sign of the Malignity of the Air, as hath been found by the constant Experience of all Miners, and therefore deserves to be the more taken notice of.

C H A P. III.

How to know the Condition of the Earth by the Taste.

THE Artist in the Knowledge of Metals, before he gives his Judgment, leaves no Experiment untried, that may be considerable for his Information. And therefore useth his Taste, which discovers the Purity of Metals, as well as Smelling doth.

Pure Earth hath no manner of Taste; and that Earth which is mixed with Minerals commonly hath a bad Taste; because scarce any Mineral but is adust, and they be all dry; whereas the very first Principle of Sweetness or good Taste is Humidity.

Now since the Earth which hath such a Mixture in it, is greatly disposed also to contain Metals of like Condition, the curious Miner ought to make Trial by Tasting; holding it for a certain Truth, that Metals of Gold and Silver, and others, are found as often in the Form of Earth (which in the *Spanish* Miner's Language is called *Lamos*) as in Stones or Oar.

The Taste of the Earth is gotten well by infusing it in curious Water, especially if you set it upon the Fire, and let it boil once or twice, and then cool again, whereby may be discerned the Mixture or Juice which it contains: And one that would improve this Experiment, may separatethe Water from the Infusion, substantially and visibly; as shall be shewn in it's Place, when we come to treat of the Preparation of Metals, to make them beneficial.

C H A P. IV.

Of the Names and Uses of some Sorts of Earth.

IN the Books of Physic some Kinds of Earth are very famous for the Effects which they have upon Man's Body ; and it is not unnecessary that the Miner hath the Knowledge to distinguish them when they come in his way.

1. *Lemnian Earth* (so called from the Island *Lemnos*, where it is found) is very red, and much like unto red Oaker or red Lead, but it hath this notable Difference, that it will not colour ones Fingers in touching it, as do the others. It is esteemed as rich as Gold, and sold so Weight for Weight : One Cause of the Dearness of it is the Scarcity of it in the World ; and another is, because they dig it only on one Day in the Year, being superstitiously persuaded, that Earth of this Kind only hath Virtue in it that is dug upon the 6th of *August*. It is a rare Antidote against any Kind of Poison or Pestilence.

2. That Earth which is commonly called *Bole Armeniac*, (from the vulgar Opinion, that it is found only in *Armenia*) is very like the *Lemnian Earth* aforesaid, only it is not red, but paleish, white, or fallow-coloured. There is excellent good of it, and in great

Plenty in the *West-Indian* Mines, and particularly in the rich Mountain of *Potosi*, and in those of *Oruro*. Divers are of Opinion, that this common *Bole* is that which *Dioscorides* calls *la Rubrica Synopica*: And that the Oriental *Bole Armeniat* is the true *Lemnian* Earth.

3. There be two Sorts of *Eritrian* Earth; one pure white, the other of an *Ash-colour*; and this last is the better, and is known by rubbing it upon polished Copper, where it will leave a Tincture of Violet Colour. It hath Virtue to stanch Blood, and to cool and heal green Wounds.

4. The Earth of *Samia* is light white Earth, and will stick to one's Tongue, if you touch it with it.

It is brittle, and yet will melt.

There is another Sort of it called *Aster*, that is close and hard as a Stone.

Both of them have the *Eritrian* Virtue in them; viz. to be excellent Antidotes against Poison, or the biting of Serpents.

5. The Earth called *Chia* is white, inclining to *Ash-colour*, much like that of *Samia*, and hath the same Virtues; and over and above that, it takes Wrinkles out of the Face, and gives a good Complexion.

6. *Selimian* Earth hath the same Quality as the last aforementioned. The best Kind of it is that which glisters much, is white and brittle, and soonest dissolves in Water.

7. *Cimolian* Earth is white, although there be a Sort of it that inclines unto Purple. The best is that which is most greasy, and is very cold in one's Hand.

It

It dissolves Imposthumes, and little Swellings, and in Case of a Burn it will keep the Flesh from blistering.

8. The *Poigite* is almost of the same Colour as the *Eritrian*, but is found in bigger Lumps: It cools and refreshes the Hand that touches it, and if one lick it, it will stick much unto the Tongue. It's Virtues are those of *Cimolian Earth*.

9. The *Melian Earth* is of an Ash-Colour like *Eritrian*; but it feels rough, and makes a Noise between the Fingers like a *Pomice-stone*: It has the Virtue of *Allum*, but very weak, as one may perceive by the Taste, for it will make the Tongue something dry: It cleanses the Body, gives a good Complexion, and will cure the Itch.

10. Of that Earth which is called *Ampe-lites*, the blackest is the best. Ground with Oil it easily dissolves, and hath a cooling and loosening Virtue: Also it is used to colour Hair withal; it is wholly bituminous as Jett is also.

Cardanus among his Curiosities makes mention of another Kind of Earth, anciently called *Britanica*, from the Country where it is found; they were said to dig very deep Mines to come at it. It was white, and after they had separated the Plate it contained, they manured their Tith-fields with the Earth, which were put in heart thereby for 100 Years after.

11. Out of Islands in the South-Sea, not far from the City of *Arica*, they fetch Earth that does the same Effect as the last aforementioned. It is called *Guano*, (i. e. Dung)

not because it is the Dung of Sea-fowls, as many would have it understood, but because of it's admirable Virtue in making ploughed Ground fertile. It is light and spungy ; and that which is brought from the Island of *Iqueyque* is of a dark grey Colour, like unto Tobacco ground small. Although from other Islands nearer *Arica*, they get a white Earth inclining to a fallow, of the same Virtue. It instantly colours Water whereinto it is put, as if it were the best Lye, and smells very strong. The Qualities and Virtues of this, and of many other Simples of the new World, are a large Field for ingenious Persons to discourse philosophically upon, when they shall bend their Minds more to the searching out of Truth than Riches.

C H A P. V.

Of Juices ; and first of Allum.

THE Compositions within the Bowels of the Earth are such as either will melt, or will not melt.

Those that will not melt are hard, and called Stones ; or being soft and easily crumbling into very small Parts, are called Earth.

Those that will melt, are either such as after they run, by the Force of the Fire, become solid and malleable ; and those are Metals ; or else such as do not obtain those Qualities,

lities, and those are they that are called Juices.

From the Mixture of the aforesaid four Kinds of Compositions are made eleven other Sorts of Minerals, and no more.

Those which are hardened by cold, ungive again by Heat, as Sulphur ; but such as are condensed by Heat are dissolved again by Cold, and Water, viz. Allum, Copperas, Salt, &c.

1. Those that write of simple Medicaments speak of divers Sorts of Allum ; but the true Allum is that which is called Rock-Allum, whereof some is white and transparent as Glass, and other some inclining to a red ; and this hath the best Virtue, and is mightily restringent ; and therefore called by the *Greeks Eshypteria*.

According to the Opinion of *Galen* ; lib. iv. *Of the Quality of Simples*, it should be of a cold Quality, because all astringent Things are so, and prescribes therefore *Rupescissa*, as cold in the second Degree, to be infused in the Quintessence of *Raymundus*. But *Dioscorides*, and many others, make it to be of a hot Quality by it's Effects ; but this is not a convenient Place to examine the Reasons of it.

2. The *Allum* which is called *Escayola*, is not a Juice, but the same with the Earth of *Samia*, which the Ancients called *Aster*.

3. Neither is the *Allum scissile*, or *de pluma*, a Juice, which is yet taken for such in Apothecaries Shops, but is the Stone called *Amianto* ; and it is not astringent to taste, nor consumes in the Fire, although it be kept there
very

very long, which are the particular Qualities of an *Amianto*.

4. The *Allum Catino* is made of the Ashes of the Herb *Anthide* or *Sosa*, (*Barilla*, or the Herb they make Glass of) whereof there is great Abundance in the Plains of *Oruro*, and in several Places of the River *Langa-Sollo*.

5. The Salt which is made of the Lees of Wine, or of the Calcinings of the Lees until they become white, is likewise called *Allum*.

The *West-Indies* abound in *Allum*, as they do also in all Sorts of Minerals. In the Mines of the *Lipes*, near unto *Coloha*, the head Town of that Country, I found a Vein of *Allum*: I have seen another in the hot Baths of *Ventilla*, in the High-way between *Oruro* and *Cbayante*; and there I saw the true *scissile Allum*, (or *de pluma*) with all the Qualities described by *Dioscorides*. This same Sort of *Allum* also is brought to *Potosi*, from another Mine near to *Porco Aylo*: And in many other Parts there is of the same; and there might of it be made in the City of *Potosi*, if they would but boil the Waters *de la Quebrada*, or *Guayco de Santjago*, which are almost all *Allum*.

CHAP.

CHAP. VI.

Of Copperas.

THE *Copperas* is a Mineral Substance very like unto *Allum*, and oftentimes they are found incorporated together.

The Manner of separating them, is to put the Lye that is drawn off from the Stone or Earth, which contains the Mineral, into boiling Urine, and the *Copperas* will divide from the *Allum*, and fall to the Bottom, the *Allum* remaining swimming on the Top. The *Copperas* is sharp and biting to the Taste, and of an astringent Quality; for which Reason divers do attribute unto it the Properties of Sulphur, Iron, and Copper, the Virtue of *Allum*, the Subtleness of Saltpeter, and the Dryness of Salt.

Some Alchymists have written as if the hidden Virtues of the Philosopher's Stone were contained in this Mineral, whose *Latin* Name is *Vitriolum*; and they form a Saying to that Purpose, beginning every Word with one of the Letters of it, viz. *Visitabis Interiora Terræ, Rectificando, Invenies Lapidem Veram Medicinam*. *Raymundus* saith, that it is very near of Kindred to Gold, and hath the same Original and Principle; and it may be that is the Reason why some affirm, that it is a Sign of a Mine of Gold, although the Experience
in

in these Provinces doth not correspond therewith. It is ordinarily found with Copper, and in great Abundance with the black Metal, which also participates much of it, and thence takes the ill Smell it hath in working.

It is a very fine Sort of Copperas, which the *Spaniards* call *Copaquiras*; and the best and purest of all, is that they call *Piedra Lipas*, from the Mine of it found in that Province; although a few Years ago a very plentiful Mine of it hath been discovered in the Province of *Acatama*, which is of a greenish Colour, and that of *Lipa* is blew. There is also whitish and yellow Copperas, which the Painters use; and different Colours of it have caused several Names to be given it: Of this Mineral are those the *Spaniards* call *Myfi Sori Calohitis*, and *Melanteria*.

There is dispute enough about it's Temperament and Qualities, as well as about that of Allum; some not allowing it to be hot in the third Degree, will yet allow it to be so in the fourth: And others on the contrary, are of the Opinion of *Juan de Rupecissa*, (who I think follows *Raymundus*) that it is cold in the third Degree.

It is admirable to see it's Effect in *Aqua fortis*, (in which all Metals, like Salt, dissolve and are turned into Water) and an ocular Demonstration of the Possibility of the Transmutation of Metals one into another: For with Copperas dissolved in *Aqua Fortis*, without any other Artifice, Iron, Lead and Tin become fine Copper: And Silver will lose of it's Value, and be turned into Copper
also

also with a little Help of another Metal, very easy to be gotten.

By the Force of a most violent Heat they extract Oil from the Copperas, which is called Vitriol, of wonderful Virtue.

They make two Sorts of artificial Copperas, blew and green, of a Mixture of Iron, Copper, and Brimstone, put in the Fire together.

Hereafter shall be declared, how and what Mischief Copperas hath caused in the working of Metals, a Thing hitherto not taken notice of.

C H A P. VII.

Of Salt.

SALT is no less necessary than commonly known in the World : And that which is Mineral hath the same Virtue as that which is made of the Sea-water, or of the Waters of brackish Lakes or Springs. The only Difference is, that the Mineral Salt is more thick and solid, whence it comes to pass to be more astringent, and not so easily dissolved in Water as the made Salt is.

The Provinces of the *West-Indies* as much abound in Salt as they do in Metals ; and a Piece of the Sea between the *Lipes* coagulated into Christalline Salt ; as also the Salt-pits called *Garci Mendoza*, are none of the most inconsiderable Wonders of this new World.

Those

Those Pits are called *Garci Mendoza*, for their Bigness, because they be forty Leagues long, and (where narrowest) sixteen broad : And also because that sometimes in the Middle of that Space are discovered, as it were, Wells that have no Bottom, and great overgrown Fishes are seen in them. It is very dangerous travelling over this Space of Ground, for Fear of losing one's Eye-sight, because the great Glistering of the Sun-beams, upon that Place of Chrystal, puts out one's Eyes, unless they be defended with black Tiffany. There is danger of Life also in that Journey ; it having happened, that going over that Place, the Traveller and his Horse, and all have been swallowed up, leaving no Manner of Mark behind either of them.

In the *Lipes*, four Leagues from the Mines of *St Christopher de Achocolla*, there is a small Lake upon the Top of a little Hill, in a Country they call *Tumaquisa* ; in the middle of which Lake the Water boils, and leaps up, sometimes more, sometimes less ; making a frightful Noise. Out of Curiosity I went to see it, and found the Noise and Motion of it so terrible, that with Reason there be very few that dare come near the Mouth thereof. The Water is thick to that Degree, that it looks more like Dirt than Water : There is one small Gutter where it runs over, and that Water issued forth, becomes red Salt, as it runs along in little Channels. This is a mighty strong Salt, and has twice the Virtue of common Salt in the working of Metals.

It hath also been found to be an excellent Remedy for the Dysentery ; perchance it
hath

hath in it a Mixture of the red Allum, that gives it both Colour and Spirit. Hard by this Lake runs a Vein of *Piedra Judaica*; and the Country thereabouts is full of Mines of Copper.

A League and a half from *Julloma*, in the Province of *Pacages*, there be many Salt Springs, that as they gush out of the Ground in a short Time become pure white Salt, without the Help of any Art, and they increase into Heaps of Salt, until the Winter Rains dissolve and sweep them away. In the same Province near unto *Caquingora*, there be more Salt-pits like unto the former; and the like there is in several other Places. In these Parts also is found in great Abundance of the Mine or Rock-Salt, which is massy and transparent; looking like the purest Chrystal. *Julloma* hath in it plentiful Veins of this Kind of Salt. Many Years ago the Inhabitants of *Curaguara de Carangas* have enriched themselves by digging of Rock-Salt; and of later Years they have discovered Veins of it near the River of *Langa Collo*; but the Salt-Mines of *Yocalla* which God hath created near unto the rich Mountain and City of *Potosi*, that nothing might be wanting that was necessary for the working of it's Oar, yields such Abundance of Salt as is incredible; whereof is daily spent in the melting of Metals at the least 1500 Quintales, and this Consumption hath lasted for many Years.

Besides the common Virtues of Salt, which every Body knows, *Arnaldo de Villa nova* in his Treatise for the preserving of Youthfulness, says, that Rock-Salt is beyond any thing
in.

in the World for that Purpose: He calls it the Mineral *Elixir*, and prescribes, that it be prepared with Things that do not weaken it, or alter it's Properties; but he does not name the Ingredients, nor the Manner of doing it. *Juan Beguino*, in his *Tyrocinio Chymico* teaches how to extract Oil out of it of an extraordinary great Virtue; and he says, that whatsoever is preserved in that Liquor shall be kept from Putrefaction for many Ages: And he believes that this was it that preserved the Body of the beautiful Maid, which *Rafael Volaterano* speaks of, that was found in the Time of Pope *Alexander VI.* in an ancient Tomb, so fresh, as if she had but just newly died, whereas it appeared by the Epitaph, that she had been buried there 1500 Years before.

C H A P. VIII.

Of Salt Ammoniac, and other Salts.

AMONG all the Salts that Nature alone produceth, the scarcest, but of greatest Virtue, is the Salt-Ammoniac; they call it vulgarly Armoniac, and from that Name conclude, that it comes from *Armenia*, but that is not the true Name of it, but Ammoniac, which in *Greek* signifies, Salt of the Sand; and underneath the Sand (of the Sea-shore, I suppose) it is found congealed in little Pieces by it's internal Heat, and the continual burning

burning of the Sun, baked so much, that it is made the bitterest to taste of all Kind of Salt. Goldsmiths use it more than the Physicians. It is one of those they call the four Spirits, because the Fire will convert them into Smoak, and so they fly away: The other three are,

- | | | |
|---|-----------------|---|
| } | 1. Quicksilver, | } |
| } | 2. Sulphur, | } |
| } | 3. Saltpeter. | } |

It hath a particular Property to cleanse and colour Gold, and is put into the Composition of that *Aqua fortis* that dissolves it.

At this Day we have little Knowledge of the true Nitre, which was anciently made of the Water of the River *Nilus*; although *Albertus Magnus* saith, that in *Goselaria* there was a Mountain that contained a very rich Mine of Copper; and the Water that issued out at the Bottom of it, being dried, became Nitre. We know little also of *Aphonitro*, which is but as it were the Froth of Nitre.

Borax (which is called by the *Spaniards* *Chrysolica* and *Atincar*) is an artificial Sort of Nitre, made of Urines stirred together in the Heat of the Sun, in a copper Pan, with a Ladle of the same, until it thicken and coagulate, although others make it of Salt-Ammoniac and Allum.

Nitre is bitterer than Salt, but less Salt. Saltpeter is the mean between them two, and consists of very dry and subtile Parts, it grows in the Walls of old Houses, and in Stables,

Stables, Cow-houses, Hog-sties, and Dove-coats: It will grow again in the same Earth it was taken out of, if that Earth be thrown in Heaps and spared, and taken care of; or if ordinary Earth be cast up into Heaps, and watered with brackish Water, after some Years it will give a great Encrease, as profitable as Crops of Grain.

The Use of it in making of Gunpowder and *Aqua fortis* is very well known. It is used also in the melting of Metals, as shall be shewn hereafter.

CHAP. IX.

Of Juices, which the Spaniards call Betunes.

THE Betune is one of the Things that does most Damage of all unto Metals, especially in the melting of them, because it burns them, and makes them become Dross, if they be not cleared of the Betune before they be put into a fierce Fire. There be twelve Sorts of Betune, viz.

<i>Asphalto,</i>	<i>Maltha,</i>
<i>Pissasphalto,</i>	<i>Piedra-Thracia,</i>
<i>Naptal la-Piedra,</i>	<i>Carbones de Mina,</i>
<i>Gagete,</i>	<i>Ambar de Cuentas,</i>
<i>Azabache,</i>	<i>Ambar Olorosa,</i>
<i>Ampelites,</i>	<i>Alcanfor.</i>

But

But few of these Sorts are found mixed with Metals.

All Betunes are the Oiliness or Fat of the Earth; and although some are of opinion, that *Alchamphor* is the Weeping or Gum of the Tree *Capar*, in the Island of *Zebat*, and the Amber of another Herb called *Paleo*, in *Spanish*, whereunto it is commonly found sticking. And to the smelling Amber they ascribe for it's Original a great Fish in the Sea like a Whale, because there is great Resemblance between it and *sperma Ceti*. Nevertheless that doth not hinder, that such Substances also may, like Sweat as it were, issue forth of the Earth, and make these Juices called Betunes.

Asphalto is found in the Lake of *Sodom*, or the *Dead-Sea*, in *Judea*, into which runneth the River *Jordan*, three Leagues from the City of *Fericha*. It is nothing else but an oily Froth that swims on the Surface of the Water of that Lake, agitated and driven by the Winds and Waves a-shore, and there condenses and hardens. It is like unto Pitch, but harder, and of a better Colour. Before God overthrew those wicked Cities of *Sodom*, *Gommorrha*, *Admah*, and *Seboim*, that fertile Valley had little of this Betune in it, as may be collected from *Gen. xiv*.

These are found also in many other Places and Provinces, some whereof use them to make Candles with, instead of Oil; although in *Peru* they have not been curious in farther Search than how best to work their Oar of Gold and Silver, yet by the Plenty of them that the *Indians* bring, it is known that there are of them in the *Cordillera de la Chiriguanes*,

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in the Frontiers of *Lomnia*, although they have little Access to them, because they be in the Power of the *Indians* that maintain War against the *Spaniards*.

The *Pissasphalto* is a natural Composition of *Asphalto* and *Paz*, and so the Colour of it declares; and for want of the true natural *Pissasphalto*, they counterfeit it of those two Materials.

La Napthe is a sulphurous Liquor, sometimes white, and sometimes black also, and is that which is called Oil of *Peter*, of admirable Virtue to cure old Pains, proceeding from cold Causes. It will draw Fire to it, as the Loadstone does Iron, with that Force, that it will take fire at a great Distance from the Flame, as hath been confirmed by the miserable Experience of the *Conde de Hercules de Icontrarii*, of the Country of *Ferrara*, who having a Well in his Ground, the Water whereof was mixed with *Petreol*, and by some Breaches or Cracks in the Well much of this Water ran to waste, commanded it to be repaired; the Labourer that was let down into the Bottom of the Well desired a Candle, the better to see his Work, which was furnished him in a Lanthorn; and immediately through the Hole of the Lanthorn the *Napthe* sucked the Flame into itself, and set Fire on the whole Well, which discharged itself instantly like a great Piece of Cannon, and blew the poor Man into Pieces, and took off an Arm of a Tree that hung over the Well. The *Conde* himself told the Story to *Matiolo*, who reports it in his *Dioscorides*.

Asphalto

Asphalto and *Piffasphalto* melt in the Fire as Pitch or Wax, and by that they are distinguished from the *Piedra Gagate*, or *Ascabache*, and also from Pit-Coal, which burns and consumes it self away like Tea, or any other sort of Wood. As yet I have not heard whether there be any Betunes in these Provinces, although I perswade myself there be, if they were sought for.

C H A P. V.

Of Sulphur and Antimony.

Sulphur is a Mineral the most universally known of any. It is made of an earthy unctuous Substance, and very hot, to that degree, that it is esteemed to be nearest of kin to the Element of Fire of any compounded Substance. The Chymists call it the Masculine Seed, and Nature's first Agent in all Generation: And they say, that the difference between one thing and another, arises from the divers Preparations and Mixtures of Sulphur and Quicksilver. It hath happened to an Apothecary, that going about to make a Salve compounded of those two Materials; he has found the result to be a Plate of fine Silver. After many Considerations of this Substance, *Thophrastus Paracelsus* proceeds to contemplate the Wonders produced by Sulphur, and saith, that God by an especial Providence hath concealed those Mysteries; and that it is an evident Con-

C futation

utation of those, who oppose the Transmutation of Metals; for this Mineral doth effect it: And he teaches a way to make an Oyl, called in Spanish (*Epatica Sulphuris*) which turns Silver into Gold. And *Heliana*, the Author of a Book called *La Disquisition*, teaches the same thing with raw Sulphur, to shew the possibility of it, although it be in very little Quantity. The Smoke of it helps to fix the Quicksilver, and turn it into Plate, whereof there be many Eye-witnesses in these Provinces. And this Sulphur distilled in a Glass-still, makes the Oyl of Sulphur of such rare and admirable Virtue, especially for the French Pox, taking three or four Drops thereof every Morning for a Week together in some Liquor proper to convey it in. It is good to cure the difficulty of Urine, and the Pains of the Gout, and many other things, as you may see in *Diodorus Eubiente*, and divers other Authors. There is abundance of Brimstone in the Province of the *Lipes*, and in the Confines of the *Pacages*, and in *la Puna de Tacora*, or *los Altos de Arica*, and in many other Parts besides; it is found incorporated with Metals in the richest Mines of *Peru*.

The Antimony, or *Stibium*, which some Miners call by the Name of *Alcabole*, and others (particularly in *Oruro*) call it *Macacote*, is a Mineral very like unto that they call *Sorocha*, or Lead, that is very porous; it shines very much, and is brittle; some of it is of a reddish yellow Colour, and some there is more inclining to white, and very finely grained, as Steel shews where it is broken.

It is made of a very corrupt, and imperfect Mixture of Brimstone and Quicksilver, and
seem;

seems to be an Abortion of Nature, and the *Embrio*, which would become Metal, if it was not taken out before it's Time.

Porta Vegino, and others do teach a way to draw out of this a kind of Quicksilver, which they call *Regalo*; but it is inclining to red, and has not so lively a Motion as the ordinary Quicksilver. By *Aqua fortis* also Brimstone (whereof it is compounded) is gotten from it in it's proper Form, of a green Colour, and burns as ordinary Brimstone does.

Basilius Valentinus in his Triumphal Chariot of Antimony, having spoken of many of it's Excellencies, afterwards teaches how to make of it a Fire-stone (as he calls it) which will turn other Metals into Gold. *Paracelsus* writes much also to the same Effect; and other Chymists with a continued Voice do speak of an Oyl which is gotten from Antimony for the same purpose: But from a more certain and necessary Experience does *Matiolus* commend his Ointment, for the curing of old Ulcers, and for other Medicinal Uses.

Stibium has a drying and astringent Virtue, and the Preparation (which they call) *Hiacint* is held to be a very strong Purge, and a Provoker to Vomit. This *Alcohol* is very commonly found comprehended in the Silver Oar, and particularly in that which in *Peru* is called the black Oar; nevertheless in many Parts it is found in a Body by itself. It does a great deal of mischief in the working of Metals, as the Betune and Brimstone does, and therefore must carefully be gotten out before-hand, as shall be shewed hereafter.

C H A P. X.

Of Marcasita, Orpiment, and Sandaraca.

M*arcasita* is also called *Syrites*, which signify a Stone of Fire, because being struck with Steel, it yeildeth Fire in greater abundance than any other Mineral : Some will have it to be begotten of an undigested Vapour, others that it is composed of a coarser Sort of Brimstone, or Betune, and Stone ; it grows in all sorts of Mines, but especially where there is Copper, and the black Silver Oar, whereof it doth much participate, and perhaps that is the Reason why *Dioscorides* saith, that the *Marcasita* is a kind of Copper : and notwithstanding *Albertus* and others do think the *Marcasita* contains no Metal in it, yet Experience has taught the contrary ; for the Farmers of the Mines of *Monferrat en les Chichas*, when they begun to dig those Veins, they found the Oar to contain as much Silver as it did of *Marcasita* : And in this Mountain of *Potosi*, and others, there is a fine sort of this *Marcasita*, which is found incorporated with the black Silver Oar, and is a certain Sign of it's Richness ; there be as many kinds of *Marcasitas*, as there are of Metals, whose Colour they represent ; the most common sort looks like Gold ; being put in the Fire, it smells like Brimstone, and flames much, which is a Sign

Sign it is compounded, as has been said before.

Gold, Silver, and Copper are usually found contain'd in it : It is a great Hindrance to the melting of that Oar, where it is incorporated, dividing the Quicksilver into very small Particles, as shall be shew'd hereafter, together with the proper Remedies for it.

Orpiment and *Sandaraca* are of the same Nature and Virtue, and are only made to differ by their greater or lesser Concoction in the Bowels of the Earth. *Sandaraca* being nothing else but *Orpiment* well concocted, and by Consequence thereof, highten'd in Virtue, as is demonstrated by putting *Orpiment* into a Fining-pot, and setting it on the Fire, whereby after a convenient Concoction, it will become red, and of as lively a Colour as the most perfect natural *Sandaraca*. Where *Orpiment* is found, it is a certain Sign of a Mine of Gold, whereof also it always contains some Seed or little Particle ; as *Pliny* reports, in the time of the Emperor *Caligula*, that he did then extract some Gold out of it : since that time it has not been attempted, because the Cost does much exceed the Benefit.

The best sort of *Orpiment* is that, which is of a shining Gold Colour, that is not fast compacted, and easily breaks into Scales. The most perfect *Sandaraca* is that, which is reddest, purest, and the most brittle, of the Colour of *Cinabrio*, (an *Indian* Word, of a Gold Colour) and it hath a strong Smell of Sulphur, whereby, as also by it's other Qualities and medicinal Virtues, it is distinguish'd from *Sandix*, which is of the same

Colour, and is made of *Albayalde* well burnt in the Fire, which some also improperly call *Sandaraca*; these are Poison, by reason of their strong, corroding, and burning Quality, not only upon the Bodies of Animals, but upon Metals also, in like manner as Antimony, or Brimstone, or other dry Minerals; for by Reason of their oily parts, they take Fire, and being mingled with Metal, they burn and consume the Moisture thereof whereby the Metal moulders away, and is lost: There be other Juices that are scarcer, and not commonly known, as they report of one that is found in the Mine of *Ancobergo*, which is white and hard, and poisons the Cattle that taste it: And it may be, of this kind was that Vein, which Persons of good Credit have told me was found in the Province of *Conchucos*, in the Archbishopric of *Lyma*, with which the Inhabitants of that Country used to kill those they had a mind to be rid of; to prevent which wicked Practice, the holy Archbishop *de los Reyes*, *Don Soribio Alonso de Magrobejo*, commanded the Mine to be stopt up.

C H A P. XII.

Of the Generation of Stones.

IT is most certain, that there is some very active Principle or Virtue that operates in the Generation of Stones, as well as upon the

the rest of the Matter of the Universe, that is subject to Generation and Corruption; but the Difficulty lies in knowing what that Principle is, because it operates in no determinate Place, but sometimes Stones are made in the Air, in the Clouds, in the Earth, in the Water, and in the Bodies of Animals.

Avicenna and *Albertus* think the Matter whereof Stones are made, to be a mixture of Earth and Water; and if the greater part be Water, it hath the Name of Liquor; but if the greater part of it be Earth, then it is call'd Dirt or Clay.

That Clay which is fit to make Stones of, must be tough and slimy, such as Bricks, Pots, and other earthen Vessels are made of; for if it be not such, as soon as the Fire hath consum'd the Moisture of the Dirt, it will not hang together, but crumble into Earth and Dust: It is also necessary, that the Liquor which is to be converted into Stone be very slimy; the Experience whereof we find in our own Bodies. The Physicians being generally of an Opinion, that the Stone is begotten in the Reins and Bladder of slimy tough Humours, bak'd hard by the Heat of the Body; this Opinion touching petrifying Liquors, is confirm'd past all Question, by the Experiment of that famous Water in this Kingdom of *Peru*, near unto *Guancaveilca*; which they take and put into Moulds of what Form and Bigness they please, and expose it to the Sun for a few Days, whereby it is made perfect Stone, and they build their Houses with it: All the Cattel that drink it dye, and

from what has been said before, it is not hard to conjecture the Reason.

In a Mountain call'd *Pacocava*, a League from the Mines of *Verenguela de Pajages*, there be Springs of this Liquor, the Colour whereof is whitish, inclining to yellow, that as it runs along condenses into very hard and weighty Stone of different Shapes. Moreover any porous Substance that can suck this kind of Liquor into it, is apt to be turn'd into Stone; and of those I have seen Trees, and Limbs and Bones of Beasts turn'd into hard Stone. In the City *de Plata* I have seen Sticks of Wood taken out of that great River of the same Name; so much of which as had remain'd cover'd with the Water, being converted into very fine Stone. I saw also the Teeth and Bones of Giants, that were dug up in *Tarija*, turn'd into heavy and hard Stone.

Stones have their substantial Forms, which makes them differ specifically; yet, because we cannot come to the Knowledge of them in our Definitions, we are fain, by way of Periphrasis, to make use of Accidents and Properties. Every several form of the Stones is accompany'd with particular Virtues, as remarkable as those of Animals or Plants, and proportion'd to the length of Time Nature takes in it's Generation; but because Plants and Animals are to have so different Dispositions, and to produce such various and admirable Effects, they cannot be of so uniform, and well mingl'd a Temperament as the Stones are, nor is their soft and gentle Substance capable to endure so much Force; as neither is the Hardness of the Stones fitted for the
producing

producing variety of several Shapes, and therefore in them are found no Leaves, Flowers, Fruits, Hands nor Feet, as in Plants and Animals, though they have a greater Virtue of another kind.

C H A P. XIII.

Of the Differences of Stones one from another.

ALL sorts of Stones are reducible under some of these five following Species.

1. If they be small, very scarce, and very hard of Substance, and have Lustre, they are call'd precious Stones.
2. If they be of great Magnitude, altho' they be rare and have Lustre, they are some kind of Marble.
3. If in breaking they fall into Splinters or Scales, they are a sort of Flints.
4. If they be of a small Grain, they be Pebbles.
5. Those that have none of the above-said Qualifications, are Rocks or ordinary Stones.

But the Miners for the better Distinction of the sorts of Stone wherein Metals are engendred, use peculiar Names for them; for example, a kind of Stone like Pebble, which contains Gold, Silver, or any other Metal they call *Guiños*, which breeds a richer Vein of Metal than any other Stone.

Cachi, another sort of Stone, white like Alabaster, soft and easy to break in pieces, is all this Country call'd Salt. Much Lead is engendred in this kind of Stone, in the Veins of *Metales pacos*, which is the Name the Miners here give unto their Silver Oar.

Chumpi, which is so call'd, because it is of a grey Colour, is a Stone of the kind of Esmeril, mix'd with Iron; it shines a little, and is very hard to work, because it resists the Fire much. It is found in *Potosi* and *Chocaya* and other Places, with the black Metals and *Rescleres*.

Lamacrudria is that Stone which is close compacted, and solid, and shews not the least Grain nor Porousness when you break it, and is of a yellow Colour, and sometimes high colour'd, as Blood-red.

Almaclaneta is the Name they give another kind of Stone, which is very solid and weighty, of a dark Colour, always found in the Company of rich Metals, which are engendred in it, when it comes to be corrupted and rotten; as in like Manner is done in the *Gouños*. It grows upon the Flints of the Gold Mines, and those of Copper and Silver.

Almolacleru, or Whetstone, is that ordinary Stone, which is commonly made use of for that Purpose, and so known to every body. Divers rich Metals grow upon it, but most commonly *los Cobriscos*.

The Veins of Silver are rare and inconsiderable that are found in Pit-Coal; altho' it be a more proper Bed for Gold.

Other

Other Stones that grow in Mines, or cleave unto the Metal, they call *Ciques*, and also *Caxas*, which are rough and uneven, but not very hard, nor very spongy, and commonly have nothing of Metal in them, altho' in some rich Mines they are infected with some little, by the Vicinity of the Oar.

The Stones of *Potosi*, call'd *Vilaciques*, have been, and are very famous for the Abundance of Silver gotten out of them; and are one of the Ingredients that make this Province without Comparifon. *Vila* fignifies Blood in *Peru*, or any red thing; and for the Streakes of red this Stone hath in it, they call it *Vileciques*.

C H A P. XIV.

Of precious Stones.

PRECIIOUS Stones are either transparent, as the Diamond is, or obscure, as the Onix, or between both, as the Sandonyx and the Jasper. It is the Water which is the principal Cause of Clearness, and the Earth of the Opacity of them. So that the Reason why they excel one the other in Lustre and Transparency, is from the variety of Humours congeal'd together to compose them, which are some of them more pure and clear than others.

White Stones are made of Humour almost like Water, and so are more clear and tran-

sparent ; such is the Chrystal, and the *Iris* so call'd, because being held opposite to the Sun-beams, it much resembles the Rainbow.

The Diamond is engendred of a less clear Humour, than the Chrystal or *Iris*, and so is more obscure than either of them. The same Variety may be observed in all precious Stones of what Colour soever they be ; whether composed of Juices or Humours that be green, as the Emerald, and the Prasina ; or of blew, as Saphir, the Cajano, and some sort of Jasper ; or red, as the Ruby ; or purple, as the Jacynth and Amethyst ; or Gold-colour, as the Chrysolites and Topaz ; or of mingled Colours, as the Opalos.

In like manner it is to be imagin'd, that the other sorts of Stones that are not transparent, are engendred of a Mixture of black and thick Humours ; an Instance whereof we see in Water, which though it be naturally white and clear, yet mingled with Ink or such like Liquor, it loseth it's Transparency, tho' not the Lustre of it's Superficies.

The different Colours of the Juices or Humours ascribed, rises from the various Mixture of black and white Matter, whereof the Stones are engendred. Although *Raymundus* and many others attribute it more immediately to the Variety of Metals, of whose purest Liquors precious Stones are engendred, in the Heart of other hard Stones, whither that Liquor hath penetrated, and thereby much refined itself. And that in Estimation, precious Stones hold in Proportion to the Metals of which they are engendred, as the Ruby to Gold, the Diamond to Silver, the Emerald

to

to Copper, and the rest in like Manner. In his *Compendium* of Transmutation, dedicated to Robert King of England, he doth particularly teach the Way of making artificial precious Stones, by a Mixture of the Waters of divers Metals, as beautiful and of the same Virtue as the natural ones are. A Knowledge over and above other excellent Qualities of that rare Person, which seems to out go Human Capacity. But it is the easier to be believed, because we see Esmalts made of divers Colours, by a Composition of Minerals ground to Powder and Glass, and false Stones made in the same Manner.

Transparent precious Stones have many Faults in them, which by Reason of their Clearness are sooner discover'd by the Eye, than those in common Stones, as Spots appear the most in finest Garments; and it is rare to find a Stone that hath not some Defect or other; either Spots, or Hair, Cloud, Shadow, Salt, or other thing subject to be engendred in them, because the Humour of which it is made is not all of one Colour. A Shadow arises from the Humours being more obscure in that Part. A Cloud comes from the Humours being too white in that Part. Hairs, which are oftenest found in the Saphir, and Salt which particularly hurts the Opalos, as Lead doth the Emerald, are Impediments of different Colours from the true Colours of the Stone in which they are.

C H A P. XV.

Whether there be precious Stones in the Kingdom of Peru.

HITHERTO the Industry of the People of these Provinces hath been principally apply'd in the search after Gold and Silver, and they have neglected the Enquiry after precious Stones, altho' there have been and are many notable Indications that this flourishing Kingdom wants not this Prerogative also.

There is a constant Report, and I myself have heard it in the Country of the *Lipes*, that in the adjoining Province of *Acatama*, there have been found excellent Diamonds; and that in exchange for a little *Cocus*, worth not above two Reals, an *Indian* old Woman sold a handful of rough Diamonds, which in *Spain* were worth many Ducats. It is a Country full of beautiful Stones to see to, and therefore may very well be supposed to have Riches in it.

There be store of Amathists in a Wood call'd by that Name, which stands hard by the Mines of *Esmeruco*. And in the rich Mine of *St Elizabeth* of new *Potosi*, there be found rich and well grown Amathists among the Silver Oar. There are of the same kind of precious Stones in *Paraguay* and *Buenos Ayres*;

Ayres ; they are engendred in *Papas Lanadas*, one or two Fathom under Ground, in a very hard and heavy Flint-stone, which they call a *Coco*, because like the Coco Nut ; it is about the bigness of ones Head. The Amethyst within will be as big about as two Fingers, naturally coagulated into Shapes like fine Lace, and is more or less mature and perfect, according to the Condition it was in when the Coco burst, which it doth of his own Accord, and then makes a Report like a piece of Ordinance, and makes the Earth near it tremble for a good while ; and that just over it to break and open ; by which Tokens Men go to the Place, and dig for the Coco, which they find split in two, three, or more Pieces. This is a thing well known, and common in these Parts of the World. Near unto the Place, call'd *Aqua Caliente*, for the hot Water that there gushes out, in the Way between *Potosi* and the *Lipes*, there is a *Pampa* full of a pure transparent Chryselline Stone, form'd by Nature into several Angles, that meet in one Point : I always pickt up some of them when I went that Way ; admiring their Beauty, for exposing them to the Sun-beams, they look'd all like so many several Suns. The largest that I saw of them was about the bigness of ones Thumb.

Of this sort, altho' much smaller, yet there be abundance in the Countries of *Callapa* and *Julloma* : In the Province of *Pacages* I gather'd some also naturally cut like Rose-Diamonds, as big as large Pease ; and washing the Sand, I often observ'd amongst it little small Points of the Colour of Gold, and transparent,

parent, like unto the best Topaz ; and others of that Sort as big as Barley-corns, which if they were bigger, would be of great Esteem, and no doubt but such might be found, if hearty Industry were employ'd thereabout.

The Stones of the Mine of *Camata*, in the Province of *Larecaxa*, do vie in Beauty with the Diamond, and are worn in Bracelets and Ring in this Kingdom.

In the great Head Land of *Arica*, between the Rocks within the Port, there is a Mine, whence they get Stones transparent as Diamonds, and very near as hard, whereof also they make Jewels.

The best Turqueyes are found in *Atacama* : I have seen one in the *Lipes*, as big as a twelve-pence *English*. The *Indians* of this Country esteem it great Bravery to have Necklaces and Bracelets of small Turqueyes curiously composed. The Men wear great ones of this Kind about their Necks, like Gold Chains. They wear such Chains also of green Stones ; and the Officers of their Armies esteem them most of all, and account them the best Ransom a Prisoner can give them.

Pearls also are gotten on the Coasts of *Atacama*, and in the *Mexillones*, which are taken out of Oysters, and brought hither to sell : it is very ordinary to find Pearls in the Dressing or Eating of Oysters.

I have little Knowledge of the Fertility of the Lower Countries in these kinds, because they have little or no Commerce here. Besides my chief Intention is to give your Lordship Information of the Mines of the Provinces subject to your own Jurisdiction, and that I have

have seen in Person. Nevertheless, at the Time of the first Conquest of these Countries, there were found many and very large Emeralds in the Hands of the Natives, as appears by the Histories thereof.

C H A P. XVI.

Of other sorts of Stones.

IT doth very little import the Owners of Mines, for whose sake principally, by your Lordship's Command, I have written this Treatise, to discourse more particularly of other Stones, although the common sort of Stones, because they are so, are little inquir'd into or understood; and when in Mines they meet with some Stones of rare Colour and Transparency: Their Beauty would invite the Miners Esteem, if the Covetousness after Gold and Silver, which they seek for, did not blind their Eyes and Understandings, so that they cannot attend to look after them. But because I have given an Account of all Minerals together; and that Marbles are of next Estimation unto precious Stones: It is but Justice to treat a little of those Marbles we find in these Provinces, which I believe equal to any that we read of in Story.

The Province of *Acatama*, above all others, best deserves to be curiously enquir'd into, by able and experienced Artists; for it produces
Stones

Stones of such various Colours, and beautiful Gloss and Lustre, that only the great Quantity and Abundance of them hinders them from being reckon'd among the precious Stones.

This whole Kingdom is full of curious Altars made of these Stones, and many of them have been carry'd into *Europe*, and they have not been wrought for any other Purposes; yet either for want of Stone-cutters to work them, or because most of us in these Parts have in our Eye to return home again into *Spain* with great Estates, and care not for perpetuating our Fame in these Parts by sumptuous Buildings, for which these of sort Stones were very fit Materials.

There is a Stone in this Imperiality, worthy for it's Variety, Lustre, and Greatness, to be presented to the View of the King our sovereign Lord. It is six Palms in Length, and one Palm six Inches less in Breadth, and two Fingers thick; it is in form like a Plank or large Table; it is full of delicate Clouds, made by the Composition of it's Colours: There be some red, and shining transparently, others more obscure, as black, yellow, green and white. Upon the blackest Spot in all the Stone is resembled Snow, as it were falling upon it, or Milk, according as the White happens to be mix'd with Shadow.

In the Mines of *Verenguela de Pacagues*, there be other Stones, not inferior in the Nobleness of their Substance and Lustre, to those of *Atacama*, altho' they have not that Variety of Colours. They be white as Alabaster, and transparent; and because that Colour is not equally distributed, it causeth, as it were, Clouds,

Clouds, which gives much Gracefulness and Beauty to the Stone : No Liquor will sink into them, they be so hard, like unto Chrystal. The Font in the Church of *Fulloma* is a very large one, and yet is made of one of these Stones; and tho' it be six Fingers in Thickness, yet you may plainly see thro' the Sides of it the Light of a Candle stuck up in the Middle. In the Jesuits Colledge in the City of *Paz*, there is a famous Water-pot of this Stone, thro' whose Sides you may see the Water rise as it is poured in, just as if it were thro' transparent Glas.

C H A P. XVII.

Of some Accidents happening to Stones, and the Cause of them.

BESIDES Shining and Transparency, which as hath been said, is found in divers Stones, and in the common sort of Stones is not found; there be also other Accidents that accompany them, viz. Hardness and Softness.

Hardness is so essential to all precious Stones, that they be not held for such, upon whom the File will make any Impression. If the Matter of which the Stone is compounded be tough, and dried by a violent Fire, till the Moisture be consum'd, it causeth Hardness, because it contracts and condenses the Matter within itself. If the Matter have little or no Toughness,

Toughness, then the Moisture being easily dry'd away by Heat, and the earthy Part burnt, there will remain a Stone soft and brittle; also the ambient Cold will condense Matter and make it hard, as we see in Stones congeal'd thereby, the which will dissolve again by the Fire, and the congeal'd Humour relax and run; Stones that want Moisture enough to glue their terrestrial Parts together, when they be put into the Fire they break into small Pieces; and those which are driest of all do resolve into Dust or Lime by the Fire.

Some Stones are porous, others massy, and well put together. The first arises from the unequal and ill Mixture of the wet and dry Parts whereof it is compounded, so that the Heat exhaling the Moisture, where no earthy Substance was mingled with it, leaves a hollow Place or Pores, which make spongy Stones. As for the opposite Reason, we see the contrary Effect in massy Stones. Stones are found of various Figures, and causing as much Admiration as most Things in Nature. Perchance it may come from the various Mixture, Colours, and Veins of Stones, as you may see in their Clouds and Spots represented Towers, Sheep, and other Animals and Figures. And in Lead pour'd out upon Water often happens the like. The Story is famous of the Agates of King *Pirrhus*, that represented *Apollo* and the nine Muses as lively as the best Painter could draw them; and *Cardanus* says, he had one of that kind that was a true and exact Picture of the Emperor *Galba*.

They

They say, that in the House of *Wisdom* at *Constantinople*, there is a Marble Stone, that by the very natural Veins of the Stone, hath the Picture of *St John the Baptist*, with his cloathing of Camels Skin expressed to the Life, excepting one of his Feet, which is imperfect.

It is a sign that Nature hath not wrought by Chance, but by particular Study, and to some mysterious End, when in the same Species of Stones are found the same Marks and Figures, like those in the Fields of *Verona*, which *Leon Baptista* reports to have seen; and that they have painted upon them the Image of the Chair of *Solomon*. And another black Stone, which being broken at one End, hath painted in it exactly, and to the Life the Picture of a Serpent; and that it hath the Virtue to draw Serpents unto it. *Albertus Magnus* affirms to have seen 500 Serpents gotten upon a Stone of that kind, which was presented unto him.

When we meet with Stones that represent Animals, or the Limbs of them, or Plants, or other Things not by superficial Draught or Colouring, but in Bulk and Substance. I believe it may arise from some petrifying Liquor, which that Matter has suck'd into it's Pores, and thereby is become all Stone, and so thinks *Avicenna*: But although sometimes this may be the Cause thereof yet methinks it cannot reasonably be supposed to be so always.

At the Foot of the Mountains *Misnenses*, near unto the Lake of *Alfatia*, Stones are very commonly found that have emboss'd
upon

upon their Superficies, the Images of Frogs and Fishes in fine Copper. Anciently they call'd a sort of Stone *Conchites*, which were in all their Lineaments very like unto the Cockles of the Sea; and they thought that those Fish-shells lying a long time in Soil, where much Stones were begotten, the petrifying Liquor entring into the Pores of the Shell, converted it into Stone: And they ground this Opinion upon the Certainty that the Sea in old Time hath overflown the whole Territory of the City of *Magara*, where only these sort of Stones are found. But of latter Times all Colour of Reason is taken away from the foremention'd Conceit, by the wonderful Veins of Stone, some grey, some iron colour'd, and some yellow, which are found in the Highway as one goes from *Potosi* to *Oronesta* down the Hill. There they gather Stones that have in them Impressions of divers sorts of Figures, so much to the Life, that nothing but the Author of Nature itself could possibly have produc'd such a piece of Workmanship. I have some of these Stones by me in which you may see Cockles of all sorts, great, middle-siz'd, and small ones; some of them lying upwards, and some downwards, with the smallest Lineaments of those Shells drawn in great Perfection; and this Place is in the Heart of the Country, and the most double mountainous Land therein, where it were Madness to imagine that ever the Sea had prevail'd, and left Cockles only in this one Part of it. There be also among these Stones the perfect Resemblance of Toads and Butterflies, and strange Figures, which tho' I have heard from

from credible Witnesses, yet I forbear to mention, and not to overburden the Belief of the Reader. Over-against this wonderful Vein of Land, on the other Side of the Valley of *Oroncota*, stands that famous Piece of Land they call *Pucara*, which signifies in their Language Fortrefs, it is a Place the best fortify'd by Nature of any now known in the World, being situate very high, seven Leagues in Compass, and all surrounded with high and inaccessible Hills, only on the one Side there is a small Avenue after having past a very difficult Ascent. In it's spacious Fields, on the Top, there be many fine Brooks of Water, Wood, Pasture-ground, Commons, and Wastes, very commodious for the Support of Human Life.

C H A P. XVIII.

Of the Generation of Metals.

IT is no Wonder, that learned Men differ so much in their Opinions, about the Matter whereof Metals are engendred, because the Author of Nature seems to have created them in that Obscurity, and Depth, and to have immur'd them with hard Rocks on Purpose to hide their Causes, and to give Check to the Ambition of Man.

The Philosophers, who pretend to know the Causes of Things, besides the first Matter, which

which is the first Principle, not only of Metals, but of all other Bodies in the World, assign another Matter remote also, which is a certain moist and unctuous Exhalation, together with a Portion of thick and tough Earth, from which, being mingled together, there results a Matter, whereof not only Metals, but also Stones are made ; for if the Dri-ness prevail, Stones are begot ; but if the unctuous Humidity be predominant, then Metals are begotten : *Plato, Aristotle*, and their Followers are of this Opinion.

From the Abundance of this pure and shining Moisture, made solid, proceeds the Lustre of Metals, in whom, of all the Elements, Water is experimentally known to be most predominant, and therefore they run, and are dissolv'd by the Fire.

From the various Temperament and Purity of the aforesaid Matter, comes the divers kinds of Metals ; the most pure and fine of all which, and, as it would seem, Nature's principal Intention, is Gold.

Many to avoid difficult Disputes of this Nature, do hold with the Vulgar ; that at the Creation of the World God Almighty made the Veins of Metals in the same Condition as we now find them at this Day ; herein doing Nature a great Affront, by denying her, without Reason, a productive Virtue in this Matter, which is allow'd unto her in all other sublunary Things ; moreover, that Experience in divers Places hath manifested the contrary. A clear Example whereof we have in *Ilva*, an Island adjoining unto *Tuscany*, full of Iron Mines, which when they have dug as hollow,
and

and as deep as they can, the circumjacent Earth falls in, and fills them up again; and in the Space of ten or fifteen Years at most, they work those Mines again, and thence draw out abundance of Metal, which this new Earth hath been converted into; many do think the same happens in the rich Hill in *Potosi*; at the least all of us know, that the Stones, which divers Years we have left behind us, thinking there was not Plate enough in them to make it worth our Labour, we now bring home, and find Abundance of Plate in them, which can be attributed to nothing but to the perpetual Generation of Silver.

The Alchymists, a Name grown odious, by Reason of the Multitude of ignorant Pretenders to that Art, with more profound and practical Philosophy have anatomiz'd the Mixtures of Nature, and reduc'd them from their first Principles; and concerning the Matter of Metals, do discourse in the Manner following: The Sun, they say, and all the Stars with their Light, proper, or borrow'd, continually going round the Earth, doth heat the same, and with their subtil Rays penetrate through it's Veins; and we see things long burnt in the Fire, are converted into other terene Substances, as Wood and Stone, into Lime and Ashes; so in like manner the Earth calcined by the Celestial Bodies, mingled and boiled with Water, changes itself into the other kind of Species, that contains in itself something of the Substance of Salt and Alum. Every Day we see the same Effects in the Lees made of Lime, Ashes, Sweat and
D Urine,

Urine, all which by boiling, get the Taste of Salt. This first Matter, or Foundation of the Generation of Metals in Vitriol, which is easier to believe, since we see that all of them by Art may be reduced thereunto, and the Manner of reducing some of them shall be declar'd hereafter.

This Vitriol by the Heat of subterranean Fire, and Attraction of the heavenly, sends forth two Fumes or Vapours; the one earthy, subtil, and unctuous, and something digested, which the Philosophers call Sulphur, because it hath the Qualities thereof: The other Vapour is moist, waterish, slimy, and mingled with very fine Earth; and this is the next Matter, whereof Quicksilver is made. If these two vaporious Exhalations do find a free and wide Passage out of the Earth, then being carry'd up into the Region of the Air, they are converted into Comets, Clouds, Snow, Hail, Thunder, and other Things that appear there.

But if the aforesaid Exhalations chance to be included between hard Rocks, in strait and narrow Places, whence it cannot get out, or the Place be already full of Minerals, the said Vapours will thicken, and be turn'd into those they call half Minerals.

If these Fumes penetrating the Rocks, do not meet with a kind of clarify'd Brimstone, that shines like Silver, and is something like unto the Fire-stone, which the *Spaniards* call *Marcasita* (without which no Metal can be engendred) they will stain the Rocks with several sorts of Colours; if these Vapours ascending, and endeavouring to get out meet with any Stones so hard as they cannot penetrate them

them, then they are converted into perpetual Springs of Water ; the like Effect whereof we see in every common Still ; but if when they pass through the Rocks they meet with those two Juices, namely the Fire-stone, or Brimstone clarify'd and consolidated, as hath been said a little before, then it dissolves the said Juices, mixing itself with them, and after boiling together a convenient Time, it thickens and hardens in the Mine ; this is the Doctrine of *Bracesco* in his Comment upon *Getro* ; but the greatest Number of Alchymists do affirm the immediate Matter of Metals to be Quick-silver and Sulphur, and that from the different Proportion of their Mixture, and greater or lesser Purification, results the Difference that is found in Metals.

C H A P. XIX.

The Opinion that Quicksilver and Sulphur are the Matter whereof Metals are made, is defended.

THOSE that think nothing can be effected that comes not within the Compass of their own Capacity, a Presumption very unworthy of learned Men, and much diminishing their Credit, who are possessed therewith, from Reasons that neither convince nor are of any Force to deny, hold, that it is not possible by Art to change one sort of Metal into another. It is not proper in this Place to examine all the Arguments

of that kind, altho' the great Connexion they have with the right Knowledge of Metals, whereof we treat, makes it necessary to handle some of them, and to make the Weakness of their Foundation plainly to appear.

They say, that the Alchymists are ignorant of the Manner whereby Nature creates and brings Metals to perfection ; and that it is erroneous to say, they are compounded of Quicksilver and Brimstone, because if it were so, there would be found in the Mines of Gold and Silver, and of other Metals, several Indications and Pieces of those Juices ; whereas common Experience shews the contrary ; for Answer thereunto, the first Part of that Reason imports little ; for though it be granted, it infers no more, but that those Alchymists that went about those Transmutations, proceeded mechanically, and without good Knowledge in the Art ; but nevertheless it remains possible that such Transmutation may be made.

The second Part of the foremention'd Reasons shews plainly the great Rashness wherewith they affirm that which they know very little of ; for there is nothing more experimentally known concerning Metals, than their ordinary Mixture with Brimstone ; and the Abundance of Brimstone in Minerals is an especial good Sign of the Richness ; a sufficient Example whereof is the Rose-colour'd Oar of the famous Mountain of *Sancta Isabella* of new *Potosi*, in the rich Province of the *Lipes*, which is almost all Plate, and engendred amongst such Abundance of Brimstone, that the Cavities and hollow Places in the
Rocks

Rocks are presently on Fire, if a lighted Candle touch them.

All those Oars which they call *Soroches Mutatos*, and *Negrillos*, and all such as do touch upon Antimony, or the Firestone, are certainly known to abound in Sulphur, or Brimstone, as shall be declar'd hereafter.

In the very same Manner is Quicksilver found incorporated with the Metals, altho' it be less taken Notice of, because it is indiscernable in the Oar, as it comes out of the Ground, and when it is put in the Fire, the Quicksilver fumes away, and leaves no Smell behind it, as the Sulphur does, but it's Effects are too well experimented in the Destruction of those that labour in the Fumes where Oar is melted: and a few Years ago we have been undeceived in this Matter by the Oar of *Ghalatiri* (which is four Leagues from the City, the most celebrated and rich one in the World, *Potosi*) which being melted down, left in the Furnace a Bar of Silver, and also a great deal of Quicksilver, which they pick'd out of those Ashes that were coolest, the Plenty of Quicksilver there did expose itself to view; and afterwards taking more Pains to work in the ordinary Manner, it produc'd as much Quicksilver as the richest Stones of *Guanacavilica*, where it is possible there may be much Reliques of Plate in the great Heaps of Oar, which hitherto they have refin'd; and I do not know whether some curious Person has not already by Accident found it so, when that that is already said shall not be held sufficient to clear this Point, it will bear no Weight in the Proof, that Metals are not compounded

of Quicksilver and Brimstone, to say that these two Ingredients are not met withal in the Mines; for as parts of the Composition of Metals they have already lost their proper Forms, and are past into the Nature of that Oar, which is made up of them. But the most skilful Artists inquiring further into the Secrets of Nature, do again extract from all sorts of Metal Quicksilver, whereof they say they are most visibly and palpably compounded. I forbear to set down the Manner to avoid the occasioning of Chymical Experiments, which do more harm than good. In like Manner common Quicksilver is turn'd into fine Plate, which is a certain Proof of the Possibility and Truth of what has been said before, whereof there are so many Eye-witnesses in these Provinces, that it were a Madness to disbelieve them all.

C H A P. XX.

Of the efficient and formal Causes of Metals.

BESIDES the Heavens, which as an universal Cause, concurs in the Generation of all Things, and particularly of Metal; some other nearer efficient Cause is necessary, that having receiv'd Virtue from the Planets, may work upon the proper Matter of Metals; for the Qualities of the Elements alone are not sufficient, nor are appointed to produce any compounded Body, but only so far as they are govern'd by some other particular Virtue, as is manifestly seen in living
Creatures

Creatures. This next Cause then, or mineral Virtue, or Spirit, serves itself on the elementary Qualities, especially of Heat and Cold, for it's Instruments in the Generation of Metals ; the Heat mixeth uniformly the earthy and humid Parts together, which is the Matter whereof Metals are made, then it boils, digests, and thickens that Matter, and the Cold coagulates and hardens it, and so it hath put on the Form of Metal, and is more or less perfect, according to the present Disposition of that Matter when the mineral Spirit began to actuate it : Hereupon is grounded the Opinion of *Callisthenes*, *Albertus Magnus*, and others, who say, there is only one kind of perfect Metal, which is Gold ; and that all the others we call so, are but the Principles or Gradations unto that ; Wherefore they conceive it feasible by Art to reduce them to Perfection, and turn them into Gold : They that oppose the Possibility thereof, place the Force of their Arguments in proving that the several Species of Metals are compleat in themselves, and distinct one from another ; and therefore that a Transition of one to the other is impossible. But their Reason convinceth not, and if it were granted, the Inference would not follow ; for we see the like Transmutations, and far more difficult, perform'd both by Art and Nature. By Art Wasps and Beetles are made of the Dung of Animals ; and of the Plant *Alvaca* rightly placed and order'd Scorpions are produc'd. Also it is notoriously known, that in *Scotland* Pieces of old Ships and of Fruit that fall into the Sea turn into living Ducks ; and there

is no Comparison between the Distance of things inanimate to Animals, and that of one Metal to another. Besides many other Things that may be brought to this Purpose, It hath already been said, how some Waters turn Sticks into Stones: And in the Nourishment of all living Creatures, there is a continual Transmutation: and in Metals it is evidenc'd by the Stone *Lapis*, or Copperas, blue or green, which, as hath been said, being dissolv'd in Water without any other Artifice turns Lead, Tin or Iron into fine Copper. And although it may be argued with Probability, that Metals do differ specifically one from another, because the Definition of Metal agrees to every one of them, as well as unto Gold, for the particular Properties that agree to every one of them. And for that we see them permanent, and without any Sign, as if Nature did endeavour to change one Form into another, or heighten them into Gold; and for many other Reasons that might be alledg'd. Nevertheless, the contrary Opinion of *Callisthenes* and *Albertus* are very probable; for it is not concluding, that two Things differ *in specie*, because the same Definition agrees to both of them, unless the essential Difference that constitutes them, such be shewn therein. As if one assert a Man and a Lion to be Animals, he cannot truly infer from thence, that they are of different Species. For so *Peter* and *Paul* would be distinct in Specie, if it were not for the Differences of rational and irrational, that limit the Genius. So, although the Definition of Metal do agree unto Lead and Silver, as well as unto Gold

Gold, one cannot thence rightly infer that they differ specifically, because the one may be perfect as Gold, and the other imperfect as all the other within the same Species of Metal, as a Child is in respect of a Man, though both have the same essential Definition; the Child may grow up to Perfection, and become a Man. The different Properties of Metals also does something stumble one, since they are Accidents that accompany it's Imperfection, and so are capable of being removed; and the Permanency which they seem to have in their kind, proceeds first either from the slowness of their Growth, or Melioration, which comes not within the Compass of human Observation; when even the Growth of Vegetables is inobservable, though after a great space of time we can discern them to be increased. Or *secondly*, from the Covetousness of Mankind, that digs the Metals out of the Bowels of the Earth before they be come to their full Maturity.

C H A P. XXI.

Divers Accidents of Metals.

BEING dissolved and returning to be coagulated again, is one of the Accidents of Metals, though it be found in other things also, yet in Metals it is after a particular Manner; the Cause of this Accident is the Moisture, whereof it is composed, the which as it is hardened by Cold; so it is dissolved by the Heat of the Fire, with more or less Difficulty, according to the different Proportion, and

strong or weak Mixture of it with the earthy Substance. Tin has very much Moisture in it, and is very ill mingled with earthy Substance, and from this last comes the Crackling and Noise it makes between the Teeth, when one bites it; and from both proceeds it's Facility to melt sooner than all other Metals; next unto it Lead melts easier than silver, which hath need of a stronger Fire, because it's earthy and humid Parts are well and strongly compacted together, notwithstanding the humid doth a little exceed. Gold because it hath a better Mixture of it's Parts, and Sulphur fixed in it's Composition, or it's earthy Part, the purest that can be is harder to melt than Silver. Iron, because the earthy Part is gross and impure, and exceeds the humid, and their Mixture also being ill and unequal, burns and consumes as often as it is heated in the Fire, and will not melt of itself without extraordinary great Violence. Copper some do think to be a Metal very near of kin to Iron, and although it has a greater Proportion of Moisture in it, it is slower in melting, because it's earthy Part is very adust and burnt.

The Lustre and Shining of all Metals proceeds, as it were, from one and the same Cause; for when their Superficies is made plain, and smooth, or burnish'd, look how much the more pure and subtile the watry Part of the Metal is, so much the more Lustre they give. Gold excels all other Metals in this, as well as in many other Particulars, and next it Silver. White is a Colour common to divers Metals, although Sil-

ver be most perfectly so, I cannot imagine with what sort of Eyes *Cardanus* look'd, when it appear'd to him to be black; the Cause of Whiteness is the Moisture being terminated by the dry, fine, and well digested earthy Part; for if it were dirty, impure, combust, it would produce a blacker and duskyer Colour, and according to the Difference of the earthy Parts of Metals herein, so do their Colour come out more or less white. Gold is yellow, or red, which Colour proceeds from the Tincture that the Sulphur very much boil'd gives unto the Quicksilver, or moist Parts, whereof it is composed; as we see in all sorts of Leigh, Urine, and other Liquors boil'd upon strong Fires, that they have a red Colour infused from the earthy Substance, wherewith they are mingled; the Colour of Copper proceeds from the same Principle, although by Reason of the Impurity, Combustion, and ill Mixture of it's Parts, it does not arrive at the Colour of Gold, much less to it's Richness and other noble Qualities.

Generally Metals neither taste nor smell well, because of their sulphurous Quality, although Gold smells and tastes well, by reason of it's most excellent Temperature; or at the least, it neither smells nor tastes ill, from the same Cause also Metals soil and black ones Hands, or any other thing that touches them; but herein also Gold must be excepted, because of it's incomparable Purity; another Propriety of Metals is to be ductile or malleable, which proceeds from the Moisture being inclosed in the dry Parts, which upon the stroke of the Hammer gives way, and

changes Place, from whence proceeds the enlarging of the Metal. Of all Metals, Gold is the most ductile, next Silver, then fine Copper, Iron, Tin, Lead, &c. Metals burn and are consum'd in the Fire from unctuous Sulphur or earthy Parts ; as on the contrary, those Parts they have of Moisture or Quick-silver does defend and preserve them from it ; the Parts of Gold and Silver are so pure and strongly compacted together, so that the earthy Part defends the moist from evaporating, and the Moisture protects the earthy Parts from burning, and so they indure the Fire without any Diminution or Corruption. Other Metals waste in the Fire for want of Perfection and Compactedness of the Parts whereof they are composed.

C H A P. XXII.

Of the Number of Metals, and the Places wherein they are engendered.

THOSE who are vainly curious attributing unto the Stars and Planets particular Influence and Dominion over all sublunary Things, do appropriate the Production of precious Stones to the Superintendency of the fixed Stars, who seem to imitate them, not only in their Brightness and Lustre wherewith they twinkle, but principally in the Purity and Permanency of their Substance ; as on the contrary, for the Instability and Alteration of Form in Metals, being sometimes
Liquid,

liquid, other times coagulated, they assign them to the particular Government of the Planets, (who from the variety of their Motions are called wandering Stars) moreover they assign the Number, Names, and Colours of the Planets unto Metals, calling Gold the Sun; Silver, the Moon; Copper, Venus; Iron, Mars; Lead, Saturn; Quicksilver, Mercury; although because this last is not a Metal, some instead thereof call *Electrum* Mercury (which is a natural Mixture of Gold and Silver) which was heretofore esteem'd the most precious of all Metals; but this Subordination and Application is uncertain, as is also the Conceit that Metals are but seven in number; whereas it is very probable, that in the Bowels of the Earth, there be more Sorts than we yet know. A few Years ago, in the Mountains of *Sudnos* in *Bohemia*, was found a Metal which they call *Bissamuto*, which is a Metal between Tin and Lead, and yet distinct from them both; there are but few that know of it, and it is very possible more Metals also may have escaped the Notice of the Generality. And if one should admit the Subordination and Resemblance between Metals and the Planets, modern Experience, by excellent Telescopes has discovered, that they are more than seven. *Gallileo de Galiles* has written a Treatise of the Satellites of *Jupiter*, where one may find curious Observations of the Number and Motion of those new Planets.

Reason and Experience teacheth, that the most proper Place for the Generation of Metals is the Veins of the Earth, which do run thro' it's great body as principal Receptacles of it's
perma-

permanent Humidity, proportionable to it's Solidity and Hardness, as Blood is in the Bodies of Animals. The Rocks between which Metals commonly are engender'd, which they call *Caxas*, (or Chest) serve for Conduits, where subterranean and celestial Heat meet and unite the one with the other, stirring up Vapours, mingling and purifying the Matter of which Metals are made, without giving it time to divert and dissipate into several places ; that which communicates between Chest and Chest is called a Vein ; and that which time has moulder'd off, or the Rains carried away from the Matter that fills it, is found scatter'd up and down the Mountains broken, and tumbled away by themselves, which are the Stones of Metal ; those that understand this Art best, believe that the Gold that is found in the Sands of Rivers, has the like Original, that it is not engender'd in the Sand, as divers will have it, but in Veins of the Earth carried from thence by Rains unto the Brooks ; yet be this how it will, (although what has been said, is the more natural and ordinary way of proceeding) oftentimes it happens, that in some parts or bits of Land, they find that which is called *Creoderos*, where Metals are engender'd out of Veins by the Disposition of Matter, and the powerfulness of the mineral Virtue which there meet together.

CHAP.

C H A P. XXIII.

The manner how to find out the Veins of Metals.

THE Veins of Metals are discovered either by Art or Fortune. Violent Currents of Water wash off the first Coat of the Earth, and so leave the Veins of Metal naked to the Eye, if there be any there; great Storms of Wind many times tear Trees up by the Roots, and with them some Stones of the Metal of that Place: The same Effect also hath the falling of pieces of Cliffs and Rocks, caus'd either by Thunder-time, or great Rains, and wash away the Cement that should hold them together. Oftentimes rich Veins of Metal have been discovered by the Plough, whereof *Justin* makes mention of Gold that was found in *Spain*. In my own Ground, a quarter of a League from *Chuquiscaca*, ploughing upon the Ridge of a Hill, I discovered a Vein of *Soroches*, and 'tis very probable that the like happens in divers other Parts of these Provinces, which are so fertile of Minerals; and that the Ignorance of the Ploughmen hath been the Cause they have not profited by the Riches which Fortune hath put into their Hands. *Lucretio* in elegant Verses hath set forth, how that the Mountains being set on fire, either on purpose, or by chance, discovered the Nature
of

of Metals unto the World, melting them, and making them to run out of the Rocks wherein they lay concealed, into the Form that now they are known. By the same accident also have been, and may be hereafter, because of discovering the Veins of Metals, which the Histories of *Spain* confirm unto us in the burning of the *Pyrenean* Mountains; and much lesser Violences than those have been sufficient, when Fortune has had a mind to distribute Riches to her Favourites. A Man riding a Horseback over the Country in *Gosolaria*, by the Soil broken with the small Force of his Horses Feet, discovered a very rich Mine, as *Agricola* reports. An *Indian* Servant of mine pulling up by the Roots some Bushes of *Tola*, a Sort of Wood, ordinary in this Country, together with the Roots, pluck'd up a rich Stone of Metal, which was Silver, white, and in Dust; this was half a League from the Mines of *St Christopher de Achacalle*; he brought me home the Stone, whereby I discovered the Vein of Silver, and shewed the place unto the Officers of the Mines.

When the rich Mines of *Tuno*, in the Province of *Carangas*, began to be famous for the Riches, abundance of Soldiers flock'd down thither: some of them being very poor, fortuning to have no share in the Veins that were already discovered, and conferring together how they should get their living, saith one of them; if God please, here we shall get enough to maintain us; together with which he kick'd the Ground with his Foot, and under that small deal of Earth, which so slight a blow could turn up, they saw a piece of white Silver,

ver, which they took up, with incredible Admiration, and therewith supplied their present Occasions, without any farther labour, (the Piece of Silver being about the bigness of *Botijuela* *) and afterwards the Vein of Silver in Dust; which was found underneath that Stone (or rather pure Silver) yielded much riches both to them and others. That Mine is called the poor Man's Mine, and is the Richest of all that were in that famous Farm. The Mine of *St Christopher's* in the *Lipes*, was also found out by chance; amongst the Rocks thereof, breed great store of *Biscaches*, a little Creature about the bigness of a Hare, (Game very ordinary, and of good Nourishment in these Parts) one of these being kill'd with a Gun, the Man that shot her, found her dead upon a rich [*farellon*] of Silver, and called this Vein, *Neustra Seniors de la Candelaria descubredora*, afterwards they register'd divers other Mines, which made that Farm so deservedly famous, as that abundance of *Spaniards* resorted thither; and that it is reckoned the third best Mine in all the *Indies*, namely, next unto *Potosi* and *Oruro*.

* *Botijuela* is a Spanish Vessel, which contains about a Gallon.

C H A P. XXIV.

Besides those Veins of Metal, which do discover themselves, or are found by chance, as has been said before, there be others procured by the art and industry of Man.

TH E Colour of the superficial Earth is no small Indication, whether or no there be Metal in the Bowels of it, as has been said in the first Chapter of this Treatise, and hath been found by experience in all the Mines hitherto discovered in this Kingdom, the superficial Earth of them being of a far different Aspect from other Earth, even to the sight of those who are very little vers'd in this Matter. There is no certain infallible Rule by the Colour of the Earth, to judge what kind of Metal it contains, that being only to be known by experience and ensaying, as we see in Gold, which is ordinarily found in red Earth, or yellow tinctur'd with red, like unto a hard burnt Brick; nevertheless in the Mines of *Oruro* and *Chianta* the Veins of it are found in white Chalk; in these Provinces the Earth of other Minerals most commonly is reddish, of the colour of Wheat, after the Pattern of *Potosi*, (their first Copy) of the same Colour is that of *Seapi*, *Perira*, and others in the *Lipes*, which produce Copper; and although sometimes the Earth is found of grey, green,
and

and red Colour; yet generally it is of the Colour of Wheat. The very same kind of Earth likewise is found in the Lead Mines; so that the true knowledge of what Species the Metal is, depends upon the ensaying of the Oar.

The Veins of Metal are found sometimes above Ground in great Stones, which being broken, the Miner discerns that they contain Metal and ensays them, and sinks his Mine there, if he finds encouragement, and that it is like to be profitable; but if the Veins be covered, they hunt them out after this manner, *viz.* taking in their Hands a sort of Mattock, which hath a steel Point at one end to dig withal, and a blunt Head at the other break Stones withal, they go to the Hollows of the Mountains, where the downfall of the Rains descends, or to some other part of the Skirts of the Mountains, and there observe what Stones they meet withal, and break in pieces those that seem to have any Metal in them; whereof they find many times both midling sort of Stones, and small ones also of Metal. Then they consider the Situation of that Place, and whence those Stones can tumble, which of necessity must be from higher Ground, and follow the tract of these Stones up the Hill, as long as they can find any of them, and when they are gotten so high, that no more of these Stones appear, it is a certain Sign, that there or thereabouts begins the Vein, there then they break Earth, and run their Mines according as the Veins of Metal which they meet withal guide them.

The gushing out of Water in the Sides of the Hills are very good Signs, that the Veins
of

of Metal are near, because commonly they are the Conduit-pipes of them.

When Trees, Bushes, and other Plants, and Weeds of the same Sort, are found to run along in Rows, as if they were planted by a Line, oftentimes it proves, that a Vein of Metal runs underneath them.

The Plants that grow over the Veins of Metals, are not of so great a Growth, nor so strong a Colour, as others of that kind, because the Exhalations which come from the Veins, blast them and hinder their Perfection; for the same Reason also, the morning Dew, and the Snow which falls, is gone sooner from those Mountains that have Mines, than from those that have none, and from the Place where the Veins run, sooner than from other Places of the same Mountain.

CH A P. XXV.

Of the several Sorts of Veins; and how to find them out

ALthough the Word Vein be a general Term given to all Places, that contain Metal, yet in the particular Speech of the Miners, it is applied to those Veins that run down perpendicularly, or sloping; (which is more usual) from the Horizon, and those Veins which run parallel in the Ground, without any considerable Depression from the Horizon, they call

call *Manto*, (a Word which signifies a Cloak or Blanket, which the Women in *Spain* throw over their Heads and Shoulders.) Both these Sorts of Veins are usually found, altho' most commonly the Mines that are wrought, are those that run downwards; those Veins which are found seldomeſt of all, are those the *Spaniards* call *Sombreros* (which in their Language signifies a Hat) or a heaped Mine, which is where Metal is found in a lump together, in what Quantity or Distance ſoever, from which no Veins run, either downward or ſideways.

In what vertical Plains the Veins of Metals generally run, hath been curiouſly obſerved by all the Miners of *Europe*, as being certain Signs of the greater or leſſer Riches, and abundance of the Mine, eſteeming principally thoſe Veins that run from Eaſt to Weſt, or thereabouts, in the northern Part of the Mountain; next they eſteemed thoſe beſt (in the northern Part of the Mountain) that run North and South, or thereabouts. They gave the third Place of Eſtimation to thoſe Veins which run North and South, on the eaſtern Side of the Mountains, and valued thoſe little or nothing at all which ran the contrary way. Whether the Veins do run Eaſt or Weſt, is eaſily ſeen by the Grain of the Stones in the joining of the Stones together, or Cheſts that contain the Metal, becauſe that runs towards the Part where the Mine ends; a thing eaſy to be obſerved in the pieces of the Rocks that are found above the Superficies of the Earth; and thoſe within the Bowels of it, run after the ſame Manner; other ſuch like Signs they give us, whereby to know thoſe Brooks or Rivers
that

that have Gold in them, but with less reason, because the Gold is not engendred there, but in the Veins of the Mountains, from whence time and the downfalls of Water have worn it away ; but without disparaging the Judgment of those that have thought as abovesaid, and have written to that purpose, I say, that for the most part in the Mines of *Europe*, and of these Parts, experience hath shewed the contrary; which I foresee they will answer, by saying, that oftentimes an Effect is produced contrary to Expectation, and that these have their Exceptions as well as other Rules ; nevertheless if it be lawful for us in this other World, and opposite Climate, to make new Rules from the Experiences in the rich Mines of *Potosi*, I should assign the first Place of Riches, and abundance to those Veins that run North and South upon the northern Side of the Mountain ; which point of the Compass, with a very little Declination westward, the four principal Mines of this Mountain observe ; namely, the Mine of *Centeno*, which was the *Descubridora* ; the rich Mine ; the Tin Mine ; and the Mine of *Mendieta* ; the second Place I should give to them that run North and South, on the South Side of the Hills. A Point of the Compass parallel, whereunto run the best Veins of the second famous Mine of this Kingdom, which hath it's Name from the famous City of St *Philip* of *Austria* called *Oruro*, which in the richness of it's Veins, abundance of Metals, Depth of it's Mines, and great Concourse of Inhabitants, deservedly stands in competition with the Grandeur of *Potosi*.

In

In divers Places very rich Veins of Metal run East and West, and also to several other Points of the Compass so that the best Rule to go by in this Matter, is to follow the Metal as it discovers itself, and as long as one gains thereby, or at least saves himself, it is worth the following on, because being sure to lose nothing one hath, the Vein will lead him to great Riches ; and if the Vein be large, and have any Signs of Gold or Silver in it, altho' for the present it doth not quit the cost, Men go on couragiously in the working of it, having such certain hopes of gaining great Profit ; this hath been confirmed by experience in all the Mines of these Provinces ; a fresh Instance whereof we have in the rich Mine of *Chocaiá*, (where for the instruction and encouragement of Miners) after having followed it's Veins forty Years, with very little Profit, at length they have met with the extravagant Riches, which all of us in this Kingdom have heard and seen. If the Veins of Metal be very small, they must be extream rich to be worth the following: If the Metal be found clinging about Stones, and likewise in the hollows of those Stones, it is found in Grains like Corns of Gunpowder, (being that which the *Spaniards* call *Plomo*) and is Silver unrefin'd ; altho' these Grains be but few, and the rest of the Metal have no Silver in it, nevertheless it is a Sign of the Riches of the Vein, when it meets with more Moisture. As it fell out in that great Mine of St *Christopher* of the *Lipes*, which they call the poor Man's Treasure, if as they dig forwards they meet with more abundance of those Grains,

de Plomo, it is a Sign that the rich Oar is very near. To find *Chrisecola*, *Herrumbre*, *Oropimente* or *Sandaraca* in the Mines, or Iron-coulour'd Earth, next to the Stones that inclose the Oar, or Fullers Earth between those Stones, are very good Tokens of the Richness of the Mine; it is no ill Sign also to meet with dry Earth, if it be yellow, red, black, or any other extraordinary Colour, and it is the better when there is some shew of Lead mix'd with it; Chalky Ground is very promising, and *Agricola* doth judge it a good Sign to meet with Sand in the Mines, if it be exceeding fine, and very ill to meet with Earth full of little Flints, if it hold long, without changing into another soil.

C H A P. XXVI.

Of Metals in particular; and first of Gold.

THE most perfect of all inanimate Bodies, and the most esteem'd of all Metals is Gold, universally known, and coveted by all People. It is made of the same Matter, and in the same Manner as other Metals are, (as hath been already shewn) but of Parts so pure and perfect, and so well compacted together by Decoction, that it's Substance is, as it were, incurruptible, being out of the Power of any of the Elements to be corrupted or destroyed.

although

although an incredible Quantity thereof hath been, and daily is gotten thence, yet now they begin to Work again a-fresh, and follow the Veins of it under Ground, whereas hitherto they have only gather'd up the Fragments of it, which were wash'd off by the Rains. The Province of *Larecaja* borders upon *Carabaya*, and abounds with Gold, which in divers Brooks of that Country is found in Form and Colour like unto small Shot, which being melted, and it's outward Coat and Mixture consum'd away, becomes of a red Colour; he that found this first did not know it to be Gold, until a Friend of his, unto whom I discover'd it, told him so.

Next unto *Larecaja* joins *Tipuane*, a Country inhabited by savage *Indians*, with whom we have had Wars, and made Incursions upon them, ever since the building of the City *de la Paz*, where I was present, and is now above twenty Years ago; this Country is so largely reported to be rich in Gold, that it were incredible, unless so many Eye-witnesses had affirm'd it; the proper Name of this City *de la Paz*, is *Chaquiyapu*, which we corruptly call *Chuquiabo*, which in the Language of this Country is as much to say *Chacra*, or the Farm of Gold; it hath abundance of Mines in it, that were wrought in the Time of the *Incas*; it is a soil generally known to be fertile of Metals; and in the time of the Rains the Boys often pick up Gold in the Streets in small Bits, like the Kernels of Apples, especially in that Street that goes down to the River, by the Convent of the *Predicadores*; and in the Valley of *Coroico*, and others, which

which they call *andes de Chuquiabo*, in the Cliffs on the Rocks Gold is found of a grey Colour on the Outside, like unto Lead. The Silver Mines of the famous Town of *St Philip of Austria, Oruro*, are encompass'd round about with other Hills, in which there are many rich Veins of pure Gold, which have been wrought heretofore; at present there is only one wrought, and that by my Persuasion; upon the Ridge of that Mountain, that runs over the Silver-mills, which they call *de las Sepolturas*, the Oar whereof being well ground to Powder, and ensay'd by Quicksilver, yields a considerable Profit, they have not follow'd any more of the Veins, for want of Industry, their common Trade being getting of Silver, or which I rather believe, because in those Veins they have already wrought, they have not gotten so much Gold as they expected; although that ought not to discourage them, because it may reasonably be supposed, that where so many Veins of Gold are, there be some of them very rich, if they have the good Fortune to light upon them, the same which daily Experience hath shew'd in the Mines of Silver.

The Bounds of *Chayanta* are full of Veins of Gold, and have some ancient Mines already sunk in them, and in the Sands of it's River, which is call'd, *el Rio grande*, Kernels of Gold are found, and in the River of *Tinquepaya*, seven Leagues from this City of *Potosi*, they have found Gold also.

In the Confines of *Pascha, Chuquichuqui*, and *Presto*, near unto the City of *Chuquisaca*, there be many Caves, out of which they have

gotten some Shew of Gold ; the like also is found from the River *Sopachuy*, up unto the *Chiriguanes*, where it is held for certain, that there be rich Mines of Gold, which the *Indians* have this Year offer'd to discover unto us.

The River of *St Juan*, which runs at the Bottom of the Province of the *Chiquas*, where it joins with the *Calchaguies*, is very full of Gold ; in *Esmoraca*, and *Chillo*, of the same Province the ancient Gold Mines are yet to be seen ; there is one Hill of the *Lipes*, which is near unto *Colcha*, which hath Gold in it ; there is a Mine also three Leagues from this Town, in a Place they call *Abitanis*, which in the *Lipean* Language is as much as to say, the Mine of Gold. I believe for a certain also, that there is Gold in the Province of *Atacama*, because of the abundance of fine *Lapis Lazuli*, which is found there, in which Gold is engendred.

C H A P. XXVII.

Of Silver, and the Mines thereof.

SILVER is the most perfect of all Metals, except Gold, whereunto it comes so near, as to want nothing but the Colour ; and therefore those that most of all oppose the Opinion of the Transmutation of Metals one into another, do yet hold it possible to turn Silver into Gold, because the Colour only being wanting, the Fire, and artificial Concoctions can supply that,

that, whereof there be many Experiments ; from the good mixture and fineness of it's Parts, proceeds it's enduring the Fire with very little waste, as also it's being tough and malleable, and endures the drawing out into very thin Leaves, and small Wire ; if it were not a common Trade to do it, it would not be believed to be possible, that an Ounce of Silver should be drawn out into 1400 Yards of Wire ; and it is yet more admirable, that all that shall be made gilt Wire, with only six grains of Gold ; so that although Silver can be extended to Admiration, yet Gold is a hundred times more ductile than it ; one Ounce of Gold suffering itself to be beaten to that thinness, as to overspread ten *Hanegadas* of Land.

In the Mines oftentimes Silver is found white and pure, and like, as it were, Wire woven one within the other between the Rocks, which the *Spaniards* call *Metal Machacada*, such as is found in that Mine they call the *Turks*, in the Province of *Carangas* ; in *Choquepina* a Mine of the *Ingas*, two Leagues from *Berenguela*, in the Province of the *Pacages* ; in the Mountain that I discover'd and registred, half a league from the Works of St. *Christopher*, in the Province of the *Lipes* ; in *Yaco*, of the Province of the *Charcas* ; which in the middle of it's Oar yields rich Copper, there was found last Year a Stone coated over with white Silver, the Metal contain'd within, being yellow, like unto the Colour of a Lion. And in the rich Mine of *Chocaya*, in the Province of the *Chichas*, in the richest Stones of that Oar they have found much Silver, like Wire woven together as aforesaid, and in

all the Mines of these Provinces at some time or other Stones have been found made into Silver Wire as aforesaid ; and Wedges of pure Silver ; but no other Mine hath produced the like unto that of *St Christopher's* in *Oruro*, which besides the Leaves of fine Silver, that are found between the Stones, produceth fine Silver also in small Dust, mingled with the Mould or Earth, that is dug there, which may be gotten together without any more Trouble than Washing, in the same manner as they use the Gold that is found in Sand ; but most commonly in all Mines Silver is found incorporated with the Stones, and is scarce discernable, nor to be known, but by Men of good Experience. In the Circuit of the *Charcas*, there is such abundance of Silver Mines, that they alone, if there were no other in the World, were sufficient to fill it with Riches ; in the middle of this Jurisdiction stands the wonderful Mountain of *Potosi*, of whose Treasure all Nations of the World have liberally participated ; the Excellencies whereof and of that imperial City, whereunto it hath given the Name, do so much surmount any other thing in the old, or new World, that they very well deserve a particular History to eternize their Fame ; it is surrounded for the most part, with abundance of rich Mines, that of *Porco* is the famous Mine of the *Ingas*, and the first, out of which the *Spaniards* dug any Silver ; those very ancient Mines of *Andacava* are admired by all Miners for their vast Depth, and admirable Contrivance, and plenty of Oar, which is such as promises continual Employment, for half the *Indians* of this Kingdom

Kingdom. Those of *Tabacco Nuno* are near unto a Lake call'd by the same Name, have such wonderful and costly Engines appertaining to them, that the building of them hath consumed a great Part of the Treasure of this Kingdom; that Lake contains so much Water, as would make a running River all the Year long, with which there goes Day and Night a hundred Silver mills, which grind the Oar that is gotten from it's own Banks. Within the Bounds of *Potosi* also are the Mines of *Guari-guare*, *Caricary*, *Piquiza*, *la vera Cruz*, *Si-poto*, and many others.

In the *Lipes* there be Farms of Mines of greater Fame, namely that of *St Isabel* of new *Potosi*, the Name whereof doth not more predicate it's Beauty, than doth the Amenity of the Mountain and the richness of the Oar that is found there. *La Trinidad* is a wonderful rich Mine, there be also the Mines of *Esmoruco*, *el Bonete*, which they call so, because the Top of the Mountain is like a Bonnet.

Xanquegua, the new World, which hath been discovered in my Time, yields very rich Veins of Metal; namely, *Abilcha*, *todos Santos*, *Osloque*, *St Christoval*, *de Achocalia*, *Sabalcha*, *Montes claros*, and many others. In the *Chicas* are *St Vincent*, *Tatafi*, *Monferrat*, *Esmoraca*, *Tafna*, *Sbina*, *Chorolque*, old and new *Chocaya*, which to the Shame and Astonishment of the Miners, hath been now last of all found out, and is one of the richest in all *Peru*.

C H A P. XXVIII.

*Continuing the Discourse of the last Chapter,
touching the Mines of Silver.*

THE Province of the *Charcas*, besides the rich Mountain of *Potosi*, which alone was sufficient to eternize it's Name, and the other Mines aforesaid, that are round about it, hath also the Mines of *Yaco*, or the Mountain of Miracles, those of *St Pedro de buena vista*, and those of *Malcocota*; there is Silver Oar also found near unto *Cayanta*, and also in *Paccha*, and *Tarabuco*, not far from *Chusquisaca*, and in other Places. Within the Jurisdiction of *Panna*, stand the three great Mountains, *St Christoval*, *Pie de Gallo*, and *la Flamenca*, which together make up those Mines, which they call of *Oruro*, that famous Town, which is near unto them. In the neighbourhood of *Oruro* also are the Mines of *Avicaya*, *Berenguela*, *Cicacica*, *la Hoya*, y *Colloquiri*, which although it is a Mine of Tin, yet now and then in following the Veins thereof they meet with rich Oar of Silver, which they call *Lipta*; in the Province of the *Pacages* is the rich Mine of *Berenguela*, with the Mountains of *Santa*, *Juana*, *Tampaya*, and others, and in the Bounds of the City de *la Paz*, there are the Mines of *Choquepina*,
Pacocava,

Pacotava, *Tiaguanaco*, and divers others ; briefly all these Provinces are nothing but a continued Mine, and notwithstanding so great a Number of Mines are opened at this Day, yet it is certain, that there be many more known unto the *Indians*, which they craftily have concealed from us till this present.

There is a certain Tradition in this Country of an incomparable rich Mine belonging to the Village of *Chaqui*, four Leagues from this Imperial City, although at present the Sight of it is not known, divers *Indians* having kill'd themselves out of Obstinacy, that they might not discover it.

There goes no less Fame of the Mine, which they call *de los Encomenderos* in the Province of the *Lipes*, which Name was given it divers Years ago by the *Indians*, who getting a Quantity of Silver out of that Mine, gave that Treasure unto two *Spaniards*, whom they dispatch'd away into *Spain*; as their Agents, they were two Brothers of the Sirname of *Tapias*, whereupon this rich Province was incorporated into the Crown. Whilst I was Curate of this Place, I spoke with many of the Country People, that told me, they had helped to load, and conduct that Riches unto the Port of *Arica*, where it was put on Ship-board ; it is agreed on all Hands, that the abovesaid Report is true, although at present that Mine remains undiscover'd, which I do not at all wonder at, when I consider, that all the Mines that are wrought in that Province have been found out, and first taken Say of, by the *Spaniards* themselves, without lighting

upon any one ancient Work of the *Indians*; whereof no doubt there were formerly very rich ones, as appears by the choice Stones, and Pieces of Oar, which *Indians* have given me, without discovering whence they had them; and the very Streets of the Town, when I was Curate there, were full of small Grains of rich Oar, which I swept up, and made Profit of it. In the Plains of *Julloma* in the *Pacages*, the *Indians* anciently have wrought Mines, which at this Day remain undiscover'd. It hath been a vast Quantity of small pieces of Plate, which they call *Corriente*, that the *Spaniards* have bought up, among this People, and I myself have gotten there some of the Remainders of that sort of Silver; these Grounds, together with the Colour and Beauty of the Mountains, makes one rationally to suspect that Country to be fertile of rich Metal; but it is more certain, that there are rich Mines in the Parish of *Caquingora*, in the same Province of the *Pacages*, because I have seen Stones of rich Oar pick'd out of the Paving of their Streets, and the Walls of their Houses. The same Report goes also of divers of the neighbouring Towns and a constant Fame, that in the Time of the *Ingas*, each of the Parties had their particular Mines.

C H A P. XXIX.

Of Copper, and the Mines thereof.

THE Sulphureous Parts do predominate in the Composition of Copper, and from their distempered Heat rises the fiery Colour of that Metal ; when it is melted it smells more of Brimstone than any other Metal ; and because it is overburnt in it's Composition, therefore it is less subject to Injury or Corruption, by the Air, Earth, or Water ; as for the same Reason, Coals are not Subject to such like Accidents ; they use Copper about Engines of long Duration, because it never rusteth as Steel and Iron doth ; and for the same Reason it was highly esteem'd by the Ancients, who made the Bolts and Nails of their Ships, their Weapons, and other Instruments, of this Metal, which also we found in use among the Natives of this Kingdom.

Copper is engendred in Mineral Stones of divers Colours, although ever the most predominant Colour is blew or green ; it is engendred in the same Places with Gold and Silver, and oftentimes in following a Vein of pure Copper they have met with a Nest of the finest Gold ; but it is more familiar to have it's Veins change into Silver ; and those Veins of Copper that make any Shew above Ground, commonly prove very rich as they are dug deeper, and consequently are more moist. The Mine of *Osoques* in the *Lipas*, was at the top
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in a manner all Copper ; and every Spades Depth as they dug downwards the Oar grew more rich in Silver, until it came to be pure Silver, at the Bottom of the Mine, where the Water increasing to a Man's Height hindred them from prosecuting it's farther Riches ; what hath been said is a Token of the Affinity between the Matter of Composition of these Metals, and that the greater or lesser Purification is the only Difference between them.

There are many Mines of Copper in these Provinces, and the Bottoms of all the Mines whereout Silver hath been taken, have been found to yield great Store of it, which for the Colour sake they call *Negrillo* ; so that how many Silver Mines there are, so many Mines there be whence Copper may be gotten also ; besides there by Mines of Copper only from the very superficies of the Earth downwards ; there be divers ridges of Hills about *Potosi*, that are full of these kind of Mines, although most of the Copper that is wrought in this Town hath been gotten from the Farm *de las Laganillas*, and now is gotten from that of *Yura*. In the *Lips* there is a very great old Work of Copper in the Mountain *Scapi*, two Leagues from *Chuyea* ; there is another also, wherein there is Copper Metal like Wire woven. A League from *Sabalcha*, in the Highway to *Colcha* ; and notwithstanding it is found in many Parts of this Province, yet no where is the Success so prosperous as in the Mountain of *Pereira* and it's Confines, until you come to *Guatacondo*.

In *Atachama* there are very large Veins of Copper, some of them run unto the Sea-side, and tumble down the Cliffs in great massy Lumps

Lumps of this Metal. In the *Chicas*, where the Soil is not taken up with Silver, it is full of Copper Mines ; and not far from *Esmoraca*, they get of this Metal, woven like Wire, or *Machacado*, as the *Spaniards* call it, there is also very rich Copper in *Oroncota*, and in the Top of the Mountains of *Tarabuco* many Pits and Copper Works of the ancients are to be seen. It is found likewise in all the rest of the *Charcas*, particularly in the Confines of *Maoba*, *Copoata*, and *Chayanta* ; and in *Paria* near unto *Oruro*. And in the Province of *Carangas*, the Hills adjoining to the Silver Mine, call'd *el Turco*, are full of Copper. Near unto *Curaguara de Palages*, there be many ancient Works of the *Indians*, whence they get Copper *Machacado*, or like Wire woven together. In the Highway between *Potosi* and *Julloma*, one sees many Veins of Copper. Also a League from *Gallapa*, in the Road that goes to the City *Paz*, one crosses some large Veins of it. Not far from *Gaquiringora* there be divers stately Works, and much Copper *Machacado* upon a white Chalk. Within less than half a League from *Julloma*, near unto the High-way that goes to *Calacoto*, in Hills of dry Clay, I found Branches or small Veins of pure Copper, like unto fine Gold, whereof I got a great Quantity of that which was scattered about above Ground. There is of this Metal *Machacado* in *Choquepina*, near unto *Berenguela de Pacages* ; and several Works and Virgin Veins in the Highway from *Calacoto* to *Potosi*, half a League before one arrives there, and in like Manner over all the rest of this Province.

C H A P. XXX.

Of Iron.

IRON, although it is not the most precious, yet it is the most necessary of all Metals for the Use of Man ; notwithstanding it may be disputed, whether the good or hurt it hath done in the World, be the greater ; Nature hath made it so hard, by putting over much earthy Parts or fixed Sulphur in it's Composition, although it hath also a sufficient Portion of Humidity, or Quicksilver, so that in the first Place it will not melt without a very violent Heat ; and, in the next Place, being struck with a Hammer, it doth not break into small Pieces, as hard Stones do, but receives Impression, thereby dilating and extending itself. It is a Metal cold, and dry, but more porous than others, and therefore weighs less, and is more subject to rust, and decay in the wet : especially in Salt Water, which penetrates most ; it wastes in the Fire also every time it is heated, falling off in Scales, because it wants Humidity proportionable to it's Earthiness. If when it is red hot, it be quenched in cold Water, it will become very brittle, because the heat being pent up in the Heart of the Iron by the ambient Cold, doth there prey upon, and consume part of the natural Moisture, which made it tough and malleable.

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These fertile Provinces of all other Sorts of Metal are not destitute of this also, though none employ their Labours to seek it out, or work it; because here is such abundance of Silver, about which they are industrious to greater Profit, and in truck for it, they buy abundance of that excellent Iron of *Biscay*; this proceeding is not to be wondred at, when one considers the abundance of Copperas, Alum, Quicksilver, and other Minerals, which is yearly brought from *Spain* to these *Indies*, where the same Commodities may be gotten in such abundance, as were sufficient to supply, not only the Occasions of these Kingdoms, but also of *Spain* it's self, and of all the World beside.

In the Valley of *Oroncota*, there is a great deal of Iron, the People of the Country being encouraged by the looks of the Place, and fair appearance of the Oar they found, followed a large Vein of Metal, hoping that it was Silver, and brought me some of the Oar to ensay it, the which I did, and undeceived them, by telling them it was Iron; the same has happened in other Veins at the rise of the River *Plicomayo*, five Leagues from the City *de la Plata*, although that Oar has some Copper mingled with it, and is not pure Iron as that of *Oroncota* is.

Adjoining to the *Ancoraymes*, a Town in the Province of *Omasuyo*, there be noble Mines wrought formerly by the *Ingas*, of so great Fame, that it is very well worth one's making a Journey purposely to see them; the Oar is very heavy, and hard, and of a dark Colour, although there be found together with

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it much Oar, that sparkles and shines. If you rub pieces of the dark Oar together, it produceth a very fine blood Colour, like that of the *Hemmotites*, to whose Species undoubtedly it belongs, and is full of Iron, as I have proved by many Ensayes; it is possible the *Indians* followed Veins of richer Metal in these Mines, which hitherto we have not met withal, or because Iron was not in use amongst them; they dug this Oar to fit it to their Guns, Stone-bows, and Slings; it being not inferior in weight or hardness to our Iron Bullets, they did make use of these in their Wars, and called them *Higuayes*.

In *Oruro*, hard by the Silver Mine of *Santa Brigida*, in the hollow between the Hills, there is a Vein of Iron, of which, out of Curiosity, and for Example only, when I was in that Town, I saw several Iron Keys made; the Metal which they call *Ghumbri*, taken out of the Mine of *Chocaya* in this Mountain of *Potosi*, and others, have much Iron in them; and doubtless there is abundance of Iron in many other Parts of this Kingdom, although the People do not regard, or seek after it, nor do the Miners in their ordinary Ensayes meddle with any thing, but the Knowledge of Gold and Silver.

C H A P. XXXI.

Of Lead.

LEAD is a very common; and known Metal, there is no Silver Mine, where much of it is not found; and there is scarcely any other Oar but has some mixture of Lead in it. Nature hath qualified it with abundance of Humidity, that it might be serviceable in the melting of Gold and Silver, which, without the help of Lead burn, away and consume in the Fire, before they arrive to their full Perfection. By reason of it's Moisture, it doth easily evaporate in the Fire, and melts; carrying along with it whatsoever is not Gold, or Silver, and therefore it's self is very easy to be refin'd; it is likest unto Gold in Weight, and unto Silver in Colour, being melted together with them. It not only facilitates the founding, and refines them, but separates the Copper from them, as shall hereafter in it's place be shewn; and therefore is the most necessary of all Things in the Art of founding of Metals, the whiteness of it shews the abundance of Humidity, or impure Quicksilver, whereof it is composed, which the Chymists in several Manner of Ways do easily separate from it.

It neither diminisheth nor corrupts by the Air or Water like Iron, but rather increaseth both.

Both in Weight and Quantity, as very good Authors do affirm, notwithstanding others do say, that Sheets of Lead exposed to the Weather do waste and consume, and have been the ruin of many goodly Buildings covered therewith. It is rarely found mingled with Gold, most commonly with Silver, and sometimes with Copper. The Oar in which Lead is engender'd, is called in this Country *Soroches*, which for the most part is black, full of Holes, and sparkling; other pieces of it they call *Muertos*, because it doth not sparkle, nor is spungy; others they call *Oques*, which in the Language of this Country is as much as to say *Fraysescos*, because it is of the Colour of a Friers Coat; there hath been no Silver Mine discovered in all this Kingdom, wherein some Lead has not been found, in which regard it is needless to enumerate the several Places that afford this Metal, although most of the Mines in the *Chicas* have abounded therein, and therefore it is that they have founded so much Metal in this Province. The Mines of *Andacava* are Lead and Silver also, but because that Oar is not proper to be separated by Quicksilver, and there is not Wood enough near the Place to melt it down; this Mine, which in my Opinion is one of the richest in all the *Indies*, continues hitherto yielding but a very small Profit. Below the Mountain of *Porosi*, as far as it's Shadow reacheth in that Part called *Desbicos*, there be many Veins of Lead, with a very little Silver mix'd in it; the like also there is within the Shadow of *St Christoval de Oturo*.

C H A P. XXXII.

Of Tin.

THE Metal which we call Tin, divers call white Lead; particularly they give it this Name, that separate Silver and Copper, in which Operation some Tin comes forth, as shall be said in it's Place, which is known by it's whiteness, and the Noise it makes when one either bites or breaks it. Common Tin is begotten from the same Principles as Lead is, but more fine and better purified, whence it becomes more hard and white, although from the ill Mixture of it's Substance it is said to rattle, and make a Noise as hath been said; it is the Poison of Metals, and makes them brittle that have the least Mixture of it, because it's Incorporation with any Metal alters the equal Temper it had before, and impedes it's Ductibility; only it doth not infect Lead in this Manner, because the exceeding great softness and humidity thereof penetrates into, and incorporates with the ill-tempered Substance of the Tin, so that united together, they remain ductile and malleable. The Veins of Tin are not found in every Place that one hath a mind to; and yet these rich Provinces are not wholly destitute of them; there is a Farm of Mines named *de Colquiri*, not far from the Hill of *St Philip de Austria de Oruro*, which

which is famous for the abundance and excellency of the Tin, that hath been gotten there wherewith they have furnished all this Kingdom, in following the Veins whereof, as hath been advertised before, many times they have met with rich parcels of Silver. Near unto *Chayanta* in the *Charcas*, there is another Mine, whence a few Years ago they got abundance of Tin. Not far from *Carabuco*, a Village on the Bank of the great Lake *Chucuito*, on that Side towards the Province of *Larecaja* there be Tin Mines also, which the *Indians* wrought in the time of the *Ingas*, and the *Spaniards* continue to work still; those Veins are very large, and rich in Tin, and many times amongst it they meet with Silver; but all of it is mixed with Copper, which makes the Tin more sightly and durable; the Fame of these rich Veins gave me the Curiosity to see them, being desirous that no Mines of these Provinces should escape my Knowledge and Experience. In the Mountain of *Pie de Gallo de Oruro*, there is much Tin, altho' few know it, and all neglect the working of it because they find not the Silver there which they expect. One of the four principal Veins of this famous Mountain of *Potosi*, is called the Tin Mine, because of the abundance of Tin that was at first found upon the Surface of the Earth, and in digging deeper it all turned into Silver. And in the Fields belonging to the Parish of *St Bernard*, where I officiate, a quarter of a League off, or a little more, there be rich Veins of Tin, which upon my discovery, your Lordship went in Person to visit, whereby, as by other of your noble

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Proceedings, you have given great Encouragement to those that are industrious in the working of Mines, which hath so eminently increased the royal Revenue, and the Riches of the People.

C H A P. XXXIII.

Of Quicksilver.

Quicksilver is a Mineral very well known, of a liquid Substance, and fluid like Water; it is naturally viscous, very subtile, and abounds in Humidity, whence it obtains the Qualities of being very heavy, and shining bright, and of being very cold, as it is generally thought, notwithstanding some do affirm it to be very hot, by reason of the subtil Effects and penetrating Quality that it hath, whereby it runs thro', not only Flesh, but the hardest Bones; and also because sublimated Mercury which substantially is nothing else but Quicksilver, though altered by the Mixture of those Minerals wherewith it is boiled and sublimated and in like Manner is reducible again to Quicksilver) is notoriously known to be Poison, and not in the first Degree; but leaving the Determination of this to those that deal in Simples, it is certain, that there is so great an affinity between the Nature of Quicksilver, and that of other Metals, that though it be none of them, yet it is convertible into any of them,

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because as most Philosophers hold, it is one of the Principles of which they all are compounded, and most easily unites and incorporates with them; and moreover it's very Substance is transmutable into true Metal, enduring the Trials of the Fire and Hammer, as well as those that come out of the Mine. *Raymundus* teacheth several Ways how to turn it into Gold and Silver, in a Book called *La Disquisition Eliana*, there is taught a very perfect Way how to make Lead of Quicksilver; and if one should suspect the Credit of Books, in these Provinces there be many Eye-witnesses that have Plate by them, which they have refined with their own Hands by a Copel of Quicksilver, cured according to a Receipt given unto them; the which Experiments take away all Scruple of the Possibility of it's Transmutation. There was very little use or consumption of Quicksilver before the beginning of this new Silver Age in the World; then they only wasted it in Mercury sublimate, *Cinabrio*, or Vermillion, and the Powders made thereof called *Precipitate*, which are also called in *Spain* the Powders of *Juanes de Vigo*, which have been used to such mischievous Purposes, that the World was said to have too much of them, although in bulk and quantity then they had but little, but since it hath been used to collect the Silver together out of Oar, which is ground small, (an Invention which the Ancients had scarcely arrived to, and practised it but very little) it is incredible, how great a quantity is consumed by the Founders of Metals of this Kingdom: For if the abundance of Silver that hath gone out of this Kingdom,

Kingdom, hath filled the World with Riches and Admiration ; by it may be estimated the consumption and loss of Quicksilver, which after a most extravagant Expence thereof at first, being now by good Experience regulated within terms of Moderation, is found to be equal in weight to the Silver extracted ; and very seldom that the waste is solittle. They began to register the Quicksilver that came to *Potosi* upon the King's Account, in the Year 1574 ; and from that time till 1640, there had been received of it upwards of 204,600 Quintails, besides a vast quantity irregularly brought in upon other Accounts ; to supply the excessive Expence of this Mineral, God Almighty provided the famous Mine of *Guanacabellica*, and in these Provinces subject to the *Charcas*, (of whose Minerals I have desired particularly to inform your Lordship) there can be no want of this Mineral amidst the great Plenty it hath of all others ; there are Quicksilver Mines in *Challatiri*, four Leagues from this Imperial City ; there be also of the same near unto *Guarina*, in the Province of *Omasuyo*, and not far from *Moromoro*, a Village of the *Indians*, six Leagues from the City *Chuquisaca* ; a few Years ago the *Indians* brought Stones very rich with Quicksilver, which by the violent Death (as was suspected) of the Man that proffered to discover the Mine, hath remained concealed unto this present.

C H A P.

C H A P. XXXIV.

Of artificial Metals and Metallics.

AR T also produces Metals and Metallics, and in their Fabrick aims at, and imitates the Perfections of Nature. From a Mixture of Tin and Copper, is made Brass for Bells, and for Pieces of Ordnance, and for other Uses. They put a Pound of Tin from four to eight Pound of Copper, according as the Occasion requires. The *Indians* understood this Composition, and made use of it for their Instruments of Force, and for their Arins, as we do of Steel or tempered Iron, which they knew nothing of.

Latten is made of small pieces of Copper put into large Crucibles, covered with Powder of *Jalamina*, (which is a Semi-mineral of a yellow Colour; there is of it near the Mine called the *Turc*, in the Province of *Carangas*, and also near unto *Pitantora* in the *Charcas*) upon the Powder of *Jalamina* they strew Powder of beaten Glass to cover it, and keep in the Respiration, and then they put Fire to it, which alters the Colour of the Copper, and makes an increase of Metal of eight Pound in the hundred Weight.

For Looking-glasses they make several Compositions, although the best is of two Parts Silver, and one of Lead. Moreover they make
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by Art, *Cinabrio*, *Mercury* sublimate, *Precipitate*, *Pforico*, *Esmalte*, *Escoria*, *Diaphryges*, *Cadmia*, *Pompholix*, *Spodos*, *Flor de Cobre*, *Suescama*, *Cardenillo*, *Vermicular*, *Stomoma*, *Herrumbre*, *Ascul*, *Albayalde*, *Sandix*, *Ochra*, *Greta*, *Purpurena*, and *Glass*.

Cinabrio is compounded of one part Sulphur; and two Parts Quicksilver, well boiled, and sublimated together in glass Vials, or in earthen Vessels that are glazed. Mercury sublimate is compounded of half Quicksilver, half Copperas, ground together extraordinary fine, and sprinkling a little strong Vinegar upon it as it grinds, that it may the better incorporate, then sublimate it in glass Vials as aforesaid; it is also made with Allum, and many times they mingle a little Salt with it.

Dissolve Quicksilver in *Aqua-fortis*, then set it upon a gentle Fire, and let the Humidity evaporate, and the Quicksilver will remain hard as a Stone, then grind it very small, and set it again upon the Fire in a Crucible, (or Vessel of Copper, if it can be gotten) and keep stirring the Quicksilver, until it be of a very lively red Colour, and then take it off the Fire for Service, and this is called *Precipitate*.

Pforico is made of two Parts of *Chalcitis*, and one of *Greta*, ground and mingled together with a little strong Vinegar; set it in a Muckhil for forty Days together, then take it out, and in a broken piece of a Pot, toast it over the Fire till it be very red.

The best *Esmalte* is made of Allum, Copperas, and Saltpetre; it is susceptible of all Colours, as Glass is.

Escoria is that which worketh out of the Metal when it runs, and swims upon the top of it like Fat, which we call Dross.

That which remains in the bottom of the Furnace, when they melt Copper is called *Diaphryges*.

Cadmia (although there be of it natural) is also that which sticks to the Walls of the Furnaces, principally wherein Copper is melted, of which they call *Bodrite*, that which is like unto *Cobos*; and *Stracita*, that which is like unto Potsherd; and *Placite*, that which looks like Bark or Shavings.

Pompholix is a mealy Substance, and looks like Wool, as it sticks to the Walls, but dissolves as soon as one's Fingers touch it. It grows upon the Walls as they melt Metal. They vulgarly call it *Atutia*.

Spodo is very little different from the *Pompholix*, only that it is more impure. It is found upon the Walls where they refine Metal.

Flower of Copper is made by pouring cold Water upon the Plates of Copper, as they come red hot out of the Furnace, which with the Fume, raise up little small Grains, which they sweep off into a little iron Fireshovel, and so preserve it.

La Escama del Cobre, is that which falls off from the Metal when it is hammered and beaten, and that which in like Manner falls off from Iron is called *Stommoma*, although this Greek Name rather signifies Steel.

Cardenillo is made by stopping Vials of Vinegar with Stopples of Copper, and letting it stand ten or twelve Days before it is used.

If instead of Copper aforesaid, they use Stopples of Iron, it makes *Herrumbre*.

Vermicular is very like to *Cardenillo*; take one Part of White-wine Vinegar, and two Parts of stinking Urine, and pour it into a Copper Basin or Mortar, and stir it about with a Pestle of the same, until it grow thick, then put a twenty-fourth Part of Salt and Alum to it, set it in the Sun, until it coagulate and dry, and it will turn into the Form of little Worms, from whence it derives the Name.

El Azul (or Blew) is made by covering a Vessel of strong Vinegar (wherein a little *Almojatre* hath been dissolved) with fine Sheets of Quicksilvered *Plantada*, full of small Holes, and putting it into a hot Muckhil, and after twenty Days standing there, rake out the *Aschul* for use.

If in the former Case one puts Lead over the Vinegar, it makes *Albayalde*.

Put *Albayalde* in a Spoon, or Iron Vessel, upon kindled Embers, and stir it until it looks very red, and then it is *Sandix*.

Ochra is yellow, it is made of Lead burnt until it come to that Colour.

Greta is made in the refining of Gold and Silver, whercof hereafter.

Purpurina is of the Colour of Gold, but of little Endurance, and lasts not long. Take four or five Parts of Tin, and asmuch Quick-silver, one Part of *Almojatre*, and another of

Sulphur, and grind them, mingle them in a glass Viol, and distil them, and the Substance that remains in the Bottom is the *Purpuring*.

In the last Place comes the most curious Production of Art, and that is the making of Glass. Take two Parts of transparent Sand, or Powder of Stones, which dissolve in the Fire; one Part of Nitre, or Saltpetre, or Salt of *Sofa* (which they call the Herb of Glass) clear and purify it with the Mixture of a little Powder of a Loadstone.

Another Receipt. Take two Parts of Ashes, and one of the Sand aforesaid, with the Powder of Loadstone, and give it a fitting Heat in the Furnace.

C H A P. XXXV.

Of the Colours of all Minerals generally.

THAT those who want Experience may the more easily know the Minerals that come to their Hands, and that by their Eyesight (the truest Informer of all the Senses) they may know what they meet with in the Bottom of Mines, I shall reduce all Sorts of Minerals into Colours, as to a *Genius* most familiarly known; some Sorts of *Greta*, (or Fullers Earth) Allum, *Amianto*, the *Arabic* Stone, the *Meliti*, the *Gallatiti*, (or the Milk Stone) Alabaster, the Diamond, Silver, Quick-silver, Tin, and Marble, are of white Colour.

la tierra Pingiti, *Jeat*, *Sori*, *Melanteria*, are black ; of an Ash Colour are the *Eritrian*, and the *Melian Earth* ; of Blue is the *Saphire*, the *Ciano*, the *Turky Stone*, the *Lapis Laculo*, and *el Cibairo* ; of green Colour is the *Emerald*, the *Prasina*, the *Chrisocola*, or *Atincar*, some Sort of *Greta*, and *Vitriol*, or *Copperas* : of the yellow Colour is *Gold*, the *Ochra*, the *Chrisopacio*, the *Chrisolite*, and *Orpiment* ; of red the *Ruby*, the *Granatte*, the *Balax*, the *Cornelian*, the *Sandaraca*, *Corral*, *la Piedra*, *Seissile*, the *Hematite*, or *Blood-stone*, *Copper*, *Minio*, (or *Vermillion*) the *Lemnian Earth*, and *Almagre* ; of purple Colour is the *Jacint*, and *Amathist* ; of a clear Blue the *Jasper*, called *Boria* ; of a greenish Blue the *Cardenillo*, and the *Armenian Stone*, or *Cibairo* are of this Colour ; (and so the Painters call the Colour which they make of this stone, a verdured Blue) of a white inclining to a Red is the *Afrodesiaca* ; of a Red that is whitish, is the *Xanto* ; between Black and Red is the *Batrachiti* ; of a Black inclining to Purple is the *Alabandico* ; of a yellowish White is the *Topaz*.

There be Minerals of any one single Colour, either Black or White, or mixed together, as the *Agates*. The *Apfiso* hath red Veins dispersed upon a black Field, and contrarywise the *Nasomonite* hath black Veins upon a red Field. The *Heliotrope* in his fine green Substance hath Veins of the purest Blood ; and in *Saphire*, and *lapis Lazuli*, are seen very resplendent Gold. Two Veins, one White, and the other Red, run quite through the Substance of the *Egitilla*.

The *Eupatalo* is of four Colours, namely, Blue, fiery Red, Vermillion, Pippin Colour.

The *Orea* also is wont to be found of as many Colours ; namely, Red, Green, White, and Black.

C H A P. XXXVI.

Of the Faculties or Virtues of Minerals.

I SHALL finish this Treatise with a brief Relation of the medicinal Virtues that are found in Minerals, more than what hath been already mentioned, that those that possess them may know how to benefit by them when the Occasion serves. Some Minerals work by their occult essential Properties, (or special Form) others by the Mediation of their elementary Qualities, contrary to those of the Disease. Of the first Sort some are opposite unto Poison, and others to other Sorts of Infirmities ; and of those that resist Poison some cure the Plague, as the Emerald, the *Lemnian*, and the *Armenian* earth ; others are good against one Sort of Poison only, as the Sapphire drunk inwardly is against the biting of Scorpions. Sulphur, Nitre, and Copperas are good against the venomous Mushrooms : Salt used plaisterwise, is good against the biting of Vipers and Scorpions, drunk inwardly is good against the Poison of *Opium* and *Toad-stools*. Of those that cure by occult Qua-

lity,

lity, some stop the Blood from passing to a particular Part of the Body, as the *Hematite*; others corroborate and fortify the Stomach, when they are hung upon it by help of a String going about the Neck, as doth the true Jasper; others tied to the left Arm restrain Abortion, as doth the Eagle Stone, which the *Greeks* call *Ætites*, and if it be bound upon the left Muscle, it produces the quite contrary Effect, as also doth the Jasper; others purge gross Humours, as doth the Loadstone; others Melancholly, as the Stone *Armenia*, or *Cibairo*; others provoke to vomit, as doth the aforesaid *Armenia*, *Chrysocola*, *Copperas* and *Precipitate*.

Amongst those that work by their elementary Qualities (although generally all Minerals are drying) some heat the Body, as do Allum, Copperas, *Chalchitis*, *Misi*, *Sori*, *Melanteria* and *Cardenillo*; others cool it, as do the *Eritrian Earth*, *Stibium*, (or Antimony) *Alkayalde* and *Greta*, or *Lithargirio*. Others with the second Qualities which they possess, soften Hardness, as doth the Agate, because it participates so much of the *Betune*; others contrarywise will harden soft Parts, as doth the hard Lead and *Estibium*: some open the Pores of the Skin, as Nitre and the Scum thereof: others shut the Pores, as doth the *Samian Earth*, and all other Earth that is slimy and tough. Some dissolve Warts, and Biles, and Kernels in the Body, as the *Piedra*, *Molar*, and the *Marcafita*; others heal Wounds, as the *Chalchitis*, the *Misi*, and Allum: Others corrode the Flesh, as doth the Powder of the Stone *Asia*, and Copperas, and

Cardemillo : Some make the Flesh putrify, as Quick-lime, Orpiment, *Sandaraca*, and *Chrysocola*. Mercury sublimated, Orpiment, *Sandaraca*, and Quick-lime are Poison, because they corrode and putrify the Bowels; so also is Morter, *Albayalde*, and *Talco* calcined, because obstructing the Passage of the Spirits, they choak one.

The END of the First Book.

T H E

THE
SECOND BOOK
OF THE
Art of Metals,

Wherein is taught the Common Way

OF REFINING

SILVER

BY

QUICK-SILVER,

WITH

Some NEW RULES added for the
better Performance of the same.

Written in *Spanish*,

By ALBARO ALONSO BARBA, *M. A.*

Translated in the Year, 1669.

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EDWARD Earl of Sandwich.

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THE
SECOND BOOK
OF THE
ART OF MATHS

OF THE

SILVER



BUCK-SILVER

WITH

the assistance of the same

ALFRED ALONSO BARRA

Translated in the Year 1800
By the Right Honourable
J. D. D. Earl of Sandwich

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T H E
SECOND BOOK
 OF THE
Art of METALS.

C H A P. I.

That no Man ought to be employed to refine Metals, but he that hath been examined and licensed by Authority.

TH E abundance of Minerals, where-
 with God hath enriched almost all
 the Provinces of this new World
 (serving himself thereof as a Me-
 dium, to other high Designs of his Divine Pro-
 vidence) hath been so great, that it is scarce
 possible

possible to be believed. The Mountain and Imperial City of *Potosi*, having already yielded between four and five hundred Millions of Pieces of Eight, a quantity sufficient to make such another Hill of Silver ; it is hard to form a Conception equal unto so exorbitant a Heap of Riches : but the better to help our Imagination therein, know that, if the Ground were covered with Pieces of Eight, laid as close to one another, as is possible, they would take up the Space of sixty Leagues square, allowing five and twenty Pieces of Eight to a *Vare* of *Spain* (a *Vare* of *Spain* is thirty-three *English* Inches) and five thousand *Vares* to a *Spanish* League. This Glut of Riches, hath been the Reason why they have not applied the Care that was requisite, to prevent loss and waste in the refining of Oar, which speaking with Moderation, hath been the loss of many Millions, both for want of giving it due Law, the Nature, and Difference whereof they did not understand, and so proceeded by Chance and without good Ground ; neither knew they well what quantity of Plate the Oar would yield. And lastly, they destroyed unnecessarily abundance of Quick-silver, whereof hath been already consumed in this Imperial City, more than 234600 Quintals ; I know not whether this Neglect speaks Greatness of Mind in the Inhabitants of this Kingdom, that they despise to pick up Crums, which nevertheless were sufficient to satisfy the Hunger of many Kingdoms of the other World ; or whether it condemns the Carelessness of so wise and well governed
a Com-

a Commonwealth, that they have not used all possible Means to put a stop to so unnecessary a Prodigality. The first and fundamental Remedy whereof, is in my Opinion, that the Metals be refined by one that understands the Art, and is authorised thereunto by publick Licence, after strict Examination of his Sufficiency, which is required before the Admission unto divers Callings in the Commonwealth, without comparison of much less Importance than this is. The Masters of refining Works have taken no Care at all in this Matter, because how negligently soever they refine their own Oar, they lose nothing, but have all the Silver, either in the Plates, or amongst the Dross: and that which they refine for others, yield more Profit to these Refiners, the worse it is wrought, because more remains with them in the Dross; but both these are ill Reasons to proceed upon, because the making full Profit of their own, must cost a double Labour, and the ill refining other Mens, redounds to a publick Prejudice.

CHAP.

C H A P. II.

What Quantities, and what kind of Knowledge a Refiner ought to have.

IT is a very great Trust that is put into the Refiners, the whole Riches which this most prosperous Country produceth, being put into their Hands without Account, or any Obligation of the Quantity they are to return; their Word and Honesty only, without Reply, or Appeal from their Sentence, is the only Security of the Truth, of what the Oar hath yielded; and it had need be a strong Security, when the violent Incitation of private Interest is to deceive. He therefore that liveth continually amongst these Occasions, had need be well furnished with the Honour of a Christian, lest having his Fingers perpetually kneading in the Palte, a good deal do not stick unto them; there ought to be a great deal of Circumspection in chusing this Officer, for no Mischief that hinders the refining of Oar, or extravagant Consumption, or loss of Quicksilver, can occasion so great Prejudice as a Refiner of a wicked Conscience.

Neither yet is it alone sufficient, that his Manners be good, if he want the knowledge necessary to the Art of Refining. He ought to know all Sorts of Metals, their Qualities
and

and Differences, which of them are most proper for Quicksilver, and which for melting, if there be Conveniency for it. He should know the Diseases also that infect Metals, and the Way of clearing them; the Accidents of Quicksilver, and the ordinary Way of refining in great and in little; and in no case let him be admitted for a Refiner, that doth not well understand how to make the lesser Ensay by the Fire, of Oar that is ground to Powder, before the Metal be incorporated together, that so he may know certainly how much Silver ought to be gotten out of that Oar; and he should never give over making Trials, until he hath obtained it. The want of this one Care has cost this Kingdom abundance of Money, and is of great Prejudice to it, even at this Day; two Experiments whereof I shall relate, which have passed through my Hands, that you may the better estimate the Importance of this Advice: A few Years ago, when I lived in the Province, of the *Lipes*, in a Parish which they call *Xauquegua*, a Miner had wrought a Vein, out of which he drew a Quantity of very rich Metal, although he knew it not; he ensayed it by Quicksilver, and found it to contain four or five Pieces of Eight the Quintal, and at that Rate refined it all by the great; at length they deserted the Mine for being of little Profit: Afterwards an *Indian* carried me to the Place, I found Metal in the Moulds that were drawn out, and also in the Fein which had not been much wrought, I ensayed it by the Fire, and found it to contain 900 Pieces of Eight the Quintal,

tal, although by the ordinary Way of Quicksilver it yielded but four or five ; I discovered this Vein to the Magistrates, calling it by the Name of *Nuestra Senora de Begomia* ; they built a Mill presently near it, and abundance of Miners flocked thereupon, and have gotten thence a great quantity of Silver.

In the Mountain of *Santa Juana*, out of the Mine of *Berenguela de Pacages*, they got a Metal like unto *Soroches*, which by the ordinary Ensay with Quicksilver, appeared scarce to have any Silver at all in it ; whereupon the Miners utterly deserted it, until a Priest, a Friend of mine, sent me some Pieces thereof unto *Oruro*, which I ensayed, and found them to contain 60 Pieces of Eight the Quintal ; by my advice he dug a great quantity of that Metal, being laughed at by the Neighbours whilst he was at work to so little purpose (as they thought) but afterwards much more envied by them for the great Riches he had gotten.

C H A P. III.

Of the Knowledge of Metals, and the Differences there are of them.

IT is almost impossible to teach those that have not been acquainted with Metals, how to know them by the Sight, because there is so great Diversity of them ; that there is
scarce

scarce any Stone in one Mine that resembles Stones of the same Metal in another Mine ; no nor oftentimes of the same Mine itself. Nevertheless the Miners reduce these Differences unto three general Heads, which the *Spaniards* call, 1. *Pacos*. 2. *Mulatos*. And, 3. *Negrillos*. *Paco* in the general Language of this Country, is as much as to say of a red Colour, and such more or less are the Stones, which they call *Metal Paco*, although in *Berengula de Pacages*, they call the Green Metals of Copper by the same Name, which also in these Provinces they give to Metal of any Colour, in contra-distinction to Metals, that shine like Steel or Glass, and another Sort which they call *Negrillos*. *Mulatos* is a Colour between the *Pacos* and *Negrillos* ; and in the Mines, Metal of that Colour is produced in the same Order ; it is of a brown Colour, and ordinarily accompanied with some of the *Margagita* ; there is less of this Metal, than of the two other Sorts. The *Negrillas* have been discovered by, and take their Name from their Colour, although all black Metals are not comprehended under that Name. *La Tacana* a rich Metal, and usually black, although there be of it Grey, and Ash-coloured, which they call *Lipta*, belongs to the Metals *Pacos*, as also doth the Lead (for so they call the Silver Oar) which oftentimes is Black, Grey, Ash-coloured, Green, White, and Orange-tawny, which they call *Suco* ; and this last Year in the Mountain of *Potosi*, there was found of it, of a bright lively Cinnamon Colour, or very fine Vermilion, a thing which hath not been seen in any other Mine. The

Sora-

roches might constitute a fourth Order of Metals, but I agree with the Opinion of others, that would have them ranked under the Name of *Negrillos*, to which also belongs the *Rosicler*, the richest Metal that Nature hath produced in the Form of a Stone; it is shining and brittle, and the Powder of it beaten finer with any hard thing, is of the Colour of pure Blood, it is very like unto *Cinabrio*, or that Vermilion which is made of Quicksilver and Sulphur, which gives a good hint for the finding out of divers other greater Secrets, *Cochico* is also of the same Kind a very rich massy Metal, but neither so brittle nor spungy as the *Rosicler* is, but it is more full of Lead, and is not so easily beaten to Powder, nor gives so perfect a blood Colour.

Soroches, *Tacana*, *Polverilla*, *Rosicler*, *Cochico*, and *Negrillos*, are distinguished one from another, in the Manner following.

The *Soroches* are black, or Ash-coloured, either shining, or without any Lustre (which they call dead Oar of Lead) and commonly contains some Silver.

The *Tacana* is Silver Oar close compacted, of a black Colour, without any shining at all.

Polverilla is *Tacana*; not congealed, nor stony, but is rich in that Oar they call *Pacos*, but not so much in the *Negrillos*, (by reason of the Mixture of Copper that it hath.

The *Rosicler* and *Cochico* is Silver Oar with that same Varnish, which hides it's own proper Colour, and shines, whereby it differs from the *Tacana*. That which predominates in the *Negrillos*, is Copper, either actual, or

else

else virtual in the Copperas, wherewith it abounds ; it always contains Silver more or less, and is usually accompanied with the *Margagita*.

The black Metal which feels like Lead, and is smooth (which makes as it were Leaves of Trees or Feathers) contains a great deal of *Alcohol*, or Antimony (which in some Parts they call *Macacote*) and but little Silver. Those *Negrillos* which have Lustre like polished Steel, or Looking-glass, and are therefore called *Espejado* and *Acerado*; are the richer the nearer they approach unto the *Rosicler* and *Cochico*.

C H A P. IV.

Of the sorting of Oar, and the proper Manner of refining each of them.

THE Skill of extracting all the Silver out of any Oar, begins to be exercised in the picking and sorting of the Oar together ; the want of Care in sorting Oar from Stones, that have no Oar in them, as also the Oar of one Sort of Metal from another, hath occasioned much damage ; the least Inconvenience hath been in the Use of Quicksilver, a quantity whereof is lost together with grinding, and other Charges about that which is no Metal ; the greater Inconvenience hath been, where there was Metal, the failing to get out all

all the Silver, because they have jumbled together Oar of several Sorts, and used but one Manner of refining, whereas those Metals require a different Way of handling and time. To Ensay that Metal by Quicksilver, that requires the Fire, is to destroy it; to put that Metal in the Furnace, which is not to run, is to endamage the Metal, and to get no Profit at all; and although the several Oars be properly assigned, some to the Quicksilver, and some to the Fire, yet they have their Differences of being easier or harder to be refined according as they concur, or differ in the Remedy, that is necessary to be used for that Purpose. The Oar, which they call *Pacos*, that shines or sparkles not at all, is proper for Quicksilver. The *Tacana* also may be refined by Quicksilver, but because it is so very rich Oar, lest it should not be clean extracted, but part of it remain in the Dross, it is better to melt it in a Bath of Lead. That Oar which containing Silver in it, yet they call by the Name of Lead Oar if it be over gross, will neither grind well, nor cleave fast to the Quicksilver, and is best to be melted together with the *Tacana*.

The most proper Way of dealing with the Oar they call *Machado*, is the Hammer; the *Soroches* need the Fire, the *Rosicler* and *Cochico* are to be melted like the *Tacana*; the *Negrillos* require both Fire and Quicksilver, for they prepare all the Oar of that Kind by the Fire, for the Quicksilver by that Means collecting the Silver, either burnt, or boiled, as shall be shewed hereafter.

C H A P. V.

How to know the ill Qualities that infect the Oar, and how to purge them away.

OF various and very different Qualities are the Substances that Nature hath produced in the Veins that contain the Oars of Metals, whether they be Abortions, which the Covetousness of Mankind occasions by tearing the Oar out of the Bowels of the Earth before it's full time, which otherwise would come to be Metal in Perfection, or whether it be excrementious Superfluities of the Generation of all Sorts of Metals ; they be usually called Semi-Minerals, and are Salts, Allum, Copperas, Sulphur, Orpiment, Sandaraca, Antimony, or Alcohol, Brimstone, both white and black, and *Margagita*.

Scarce any Oar is gotten that doth not participate of one or more of these ill Companions, all of them being hindrances to the extracting Silver out of the Oar, whether it be by the Fire or Quicksilver ; those that partake of Copperas, of which sort are those they call *Copaquiras*, are mortal Enemies of Quicksilver, which they consume and scatter, and that ill Condition is heightned, if Salt be mingled with it, which makes it penetrate more violently, and suddenly ; the learned *Raimundus* knew this Antipathy very well, and hath left it discovered to us in Writing ; and those that deal in Metals daily have it in their Hands, and yet take no notice

tice of it ; this is that, which eats up the Quicksilver, and dissipates the Caxomes of Metal, and hath occasioned so great an Expence of Metals, namely, Iron, Lead, Tin, and Lime. Whosoever hath a mind to make Experiment hereof, let him mix a little Quicksilver with Copperas well ground, and Water, and he shall see in an instant all the Quicksilver dissolved and lost : especially if he put a little Salt to the former Composition. This will be no wonder to those that know *Mercury* to be Quicksilver, and that the great Change in it's Substance, is caused by Copperas and Salt, wherewith it is mingled, and then sublimated in the heat of the Fire ; this is the greatest Poison to the Refination by Quicksilver ; although sometimes it is useful, and serves like Treacle to those Sorts of Oar, which have use of it, as shall be shewed in it's Place hereafter.

This inconvenience is found out, and remedied, with very much ease ; grind a little Oar, and put some fair Water to it, heat it, the more the better, stir it well, and then let it stand a while, then pour out the clear Water into another Vessel, leaving the Sedement behind undisturbed, prove it by the Taste, and you shall well judge what Mixture it hath by it's dry or sour Taste ; and whosoever desires an ocular Demonstration of this, let him set the aforesaid Water upon a gentle Fire, simmering until the Moisture be consumed, and he shall see with his Eyes ; in that which remains at the Bottom, either Allum or Copperas. Bathe the Oar in the Manner abovesaid, so often as shall be necessary, until the Water, that comes

from

from it be sweet, and without Taste, or that stirring it with a bright Piece of Iron, it doth not stain it with the Colour of Copper, and then that Oar is perfectly cleansed and secure, not to hurt the Quicksilver, when it is put unto it.

Although Sulphur, Betune, and Antimony do oftentimes discover themselves unto the Sight, yet a better Way of finding them out is by the Smell, which comes from the Oar, when it is well burnt in the Fire; but for fuller Satisfaction herein, they may be discovered and cleared from the Oar in the Manner following.

Grind the Oar somewhat gross, and put it in an earthen Pipkin that is not glazed, that hath a great many small Holes in the Bottom of it, and stop the Mouth of it close, then fit a Vessel of Water round about it, in such Manner as they do when they clear the Pine Apples from Quicksilver, and put Fire under the same Bason of Water, wherein all the Smoak that goes out of those little Holes will settle, and there you shall see congealed and swimming upon the Top of the Water, the Sulphur, Antimony or Betune, each in his proper Form. When the Oar will smoak no longer, it is a certain sign that it is clear of those Impediments, which although they be not direct Enemies to Quicksilver in raw Oar, yet the Varnish which they give to the Silver, hinders the Quicksilver from laying hold of it, and uniting it together; and by the Brittleness and Asperity like Glass, which those Oars have that participate of the Impediments aforesaid, they cut and divide the Quicksilver when

when they are stirred together into small white Pins Heads as it were, which the *Spaniards* call *Lis*. It is necessary to burn this Sort of Oar, although it be good to melt them first before they put them into the fierce Fire, because without that Preparation the Silver will all be turned into Dross.

The *Margagita* that is in Oar, discovers itself but too plainly to the Eye by it's Weight and sharp glassy Quality ; it divides the Quicksilver into small *Lis* ; when they stir them together, those ill Qualities are taken away by the Fire, if you burn it therein untill it's gloss and shining be gone, it doth most hurt unto that Oar which they melt, the abundance of Sulphur whereof it is compounded making a great Scum upon the Face of the Liquor, which much stifleth the Fundition.

C H A P. VI.

Of the grinding of the Oars of Metal.

THE grinding of Oar is a Preparation absolutely necessary for the getting out of it the Silver, or Gold that it contains by Quicksilver, and the Fineness of the Meal is a principal Means of shortening the Work and clear Extraction of the Plate : one Fault amongst many, which the Blockishness of this Coun-

Country has committed, hath been to make the Meal very gross, or to leave many Lumps therein ; there needs no great Pains to prove that the Quicksilver attracts or incorporates with itself that Silver which it immediately touches ; so that the Metal which is in the middle of any Lump remains in the same Condition it came out of the Mine, and has more or less loss in it, according to the Richness of the original Oar, and according to the Richness or Courseness of the Meal. I have made divers Trials of grinding those Lumps over again, and find that in them remains, when least, the sixth Part of what is in the Oar when it is first taken out of the Mine, which is very considerable in a whole Years Work, and incredible in the great Quantity of Metals that have been already gotten. *Agricola* after having taught the Way of grinding and sifting of Metals, which they now practise in the Mills, teaches a Way how to reduce it to extraordinary fine Flower in a kind of Horse Mill, with Stones like Mill Stones : He thought this Pains to be necessary, although to an End different from that refining which we now practise, wherein it is clearly and indispensably necessary. I learned the Manner of doing this from one that had gotten a great deal of Money by grinding the Lumps over again, although he did not take out all the Plate, because he ground them in an ordinary Mill, whose Hammers could not beat it so small as it ought to be, for the Lumps either slipped away from under the Hammer, or being uneven one defended the other from the Stroke ; to have good Sieves,

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and

and Care in lifting them up is of great Importance to this Matter, but not a full Remedy, after the washing of the Oar, especially if it were of rich Metal is the best gathering up of Lumps to regrind. If they burn the Lumps, they will yield more Flour, because some of the Lumps will calcine and be smoother, and others will swell and grow more spongy, whereby the Blow of the Hammer will have better Effect upon them. I do use another Way of Preparation by boiling, as shall be shewed hereafter, which I do hold more proper to be used in all Refination by Quicksilver; put the Oar ground and searfed into a Skillet in like Manner (as if it were already incorporated with Quicksilver, and ready for washing) then pour a sufficient Quantity of Water upon it, stirring it with a Ladle or Hand-Mill, whereby all the fine will swim at top, and the gross and ill ground will sink to the bottom; take away the fine with a Ladle, put it in the melting Pot and boil it, grind the grosser Part again in a Mill or a Morter, until it become all Meal; if I desire to make a Xoves of the fine Sort after the ordinary Manner of refining, I must mingle some pure Sand therewith, that it may swell and want the Inconveniences which that kind of Oar useth to be accompanied withall.

C H A P. VII.

Touching the burning of Oar.

THE burning of Oar is useful for two Purposes, viz. 1. That it may grind the better, 2. That it may be in better Disposition for the Quicksilver to lay hold of, and incorporate itself with the Silver that is in it. The Reason of the first is plain, and Experience shews the latter; since they order all the Negrillos or blacker Oar in that Manner, but generally don't understand the Reason thereof. And certainly in all the Art of Refining, nothing is practised so much by Guess or Chance, and without knowing the Ground of it, as this is. Refiners will say, they burn the Oar to clear it of ill Qualities, not apprehending that thence it will follow that by Fire enough they should quite cleanse and purify it, whereas the contrary is found by Experience; and that according as they burn it more, the worse conditioned is the Oar, and needs the Help of some other material to prevent that all the Silver and Quicksilver too, that is in it, be not lost.

There is but one Enemy naturally opposite unto Quicksilver (as hath been said already) and that is the Copperas, and the Fire is not only useless for the vanquishing that, but on the contrary it multiplies and encreases it;

and if the Oar have no Copperas in it when it is put into the Fire, the Fire will beget and prodoce it, as may easily be seen by Experiment. In the burning of Negrillos (or black Oar) in which the Fire encreases the Copperas so much, that it is necessary to use other Materials in the burning of it to repair that Damage, although if they had thoroughly understood this Matter, they might have cheaper and easier done it, by washing the Oar (as I have said before) until it was cleared of all the Copperas; the Ignorance of which Remedy hath been the Occasion of great Waste and Loss.

Other Diseases of Oar do not directly injure the Quicksilver, only by the Varnish and glassy Quality which they give, they hinder the Plate and Quicksilver from incorporating and making a Mass together; and therefore the Rule in this Case is to burn the Oar so long until it change Colour and lose the Lustre and Sparkling that it had. To know the Oar that of Necessity must be burnt (if it be to be refined by Quicksilver) the Lustre and Shining aforesaid is a certain Sign. The Fire will not prejudice that Oar they call Pacos, and if it have any Mixture of the aforesaid Impediments, it must of necessity be burnt.

C H A P. VIII.

Touching the Damage that results from the burning of Oar.

MEN having hitherto proceeded by Chance as it were, and without certain Knowledge of the Quantity of Silver contained in a Piece of Oar have judged him the best Refiner that has gotten most Silver by one Operation, leaving it doubtful whether any more or no were to be gotten out of the Oar, especially in the Negrillos and Oars that cannot be excused from burning. This Doubt has been greater, there being less Certainty here where there ought to be much the greater; and from hence Men have found no less Inconvenience by mistaking on the one Hand, than on the other; wherefore this Manner of Preparation hath been esteemed, as dangerous as profitable. With Skill and Curiosity one may observe many Wonders of Nature in the burning of Oar, the Parts of Iron and Brimstone, which commonly accompany the Oar, when they come to the Fire are converted into Vitriol or green Copperas; this afterwards is turned into fine Copper; again, the Copper calcined, dissolves in Water like Salt, the which strained and evaporated by a gentle Heat, coagulates

into another kind of Vitriol, or blue Copperas, like unto that which they call the Sone *Lipes*, and is of admirable Virtue for the turning of almost all Metals into Copper; the Purity of Silver itself does not excuse it from being subject to such a Metamorphosis; for if the Oar have in it any Allum, Copperas, Saltpetre, or Nitre, by the Help of the Fire they will calcine the Silver so, that it will dissolve in Water, and not be laid hold on by Quicksilver without using some new Artifice; and even Salt alone as it grows incorporated in the Oar, or mingled with it in the Fire is capable of producing the same Effect as shall appear evidently in the following Experiments.

C H A P. IX.

Experiments which prove the Damage by the burning of Oar if they be not known and remedied.

GRIND a Piece of Oar that has Copper or Iron in it, and by the Direction of the Fifth Chapter of this Book, try if there be any Copperas in it, and if there be, clear the Oar of it by washing of it, and after it is dry burn it well, and put it into Water again, and you shall see much Copperas anew produced by the Fire; the Refiners daily do this with their Hands, although they take no Notice

Notice of it ; and although this Experiment be sufficient to satisfy every body, yet for greater Confirmation of this Secret to grind Oar of Copper or Iron, and melt it into thin Plates, and grind some Sulphur, and in a Crucible or earthen Pot unglazed, put a Lare of that Sulphur, and upon that lay one of the Plates, and proceed in that Order as far as you think fit, stop the Mouth of it well, that it give no Vent ; and after it is dry, put it between red hot Coals in such Manner as they encompass it round about, but do not touch it ; after the Crucible is sufficiently hot, put the Fire nearer to it, and at last make the Fire fierce ; but not so much as to melt the Plates ; then take it out, and the Plates will look black and be brittle, grind them very fine, and put the fourth Part of their Weight of beaten Sulphur, together with them into a Piece of broken Pot or earthen Basen upon Embers, heat them so as you heat an Ensay of the black Oar, stirring them continually until the Sulphur have left smoaking, and the oftener you repeat this the better ; last of all, being well beaten and hot, or else the Water hot, and after a little time boil the Water, and if it colours bright Iron of a Copper Colour, that the Water evaporate by a gentle Fire, until it begins to be covered with a kind of Cream, then take it off and set it a cooling, and it will congeal into most beautiful transparent Copperas, green if the Plates were of Iron, or blue if the Plates were of Copper.

Dissolve this Copperas, or Stone *Lapis* in Water, and put Steel or Iron to it, and it turns into most pure Copper, smooth, and soft as Gold after it is new melted. If one melt Lead or Tin, and pour it in small Drops upon the Face of that Water, the whole Superficies will be turned into Copper, and the oftner it is repeated, the greater Quantity of the Lead will be transformed until no Lead remain.

Tin is very easily turned into Brass. I was the first which in the Province of the *Lipis* found out and published these Secrets. Also Silver is turned into Copper, if it be made very fine, and with much Salt (an Experiment which ought to be as highly esteemed by the Refiners, as the turning Copper into Silver). *Aqua fortis* is a common Thing, if it were not, it's Vertue would be held miraculous; it turns Silver into Water, and calcines it into Dust; it is made of Copperas or Alum and Saltpetre. The Spirits that fly from any of these Substances, when Oar that contains them is cast into the Furnace, works the same Effects with beaten Brick and Salt, especially of the Rock is made a Cement, wherewith they separate Silver from Gold; these two attract the Silver to themselves, and with the Heat of the Fire only calcine it; in the burning of Oar they have the same Effect; the Silver being calcoined in either of the aforesaid Manners if it be put into Water, dissolves in it like Salt, and the Water looks white as Milk, and will spot one's Hands or Nails if you touch it; notable Signs of *Aqua fortis* in Silver, whereunto Refiners ought

ought to have great Regard, that it destroy not their Silver; these Inconveniences there are in the burning of Metals, besides another which anon shall be discovered, and though the proper Way of avoiding them is casting or melting the Oar which renders useful, not only that Metal which is precious, but also the baser Sort, as shall be shewn in it's Place, nevertheless because all Places do not afford Conveniences for melting down Oar, nor all Oars contain Metals rich enough to pay the Cost, let the aforesaid Inconveniences when they happen, be remedied according to the Rules which shall be set down hereafter, although it be impossible to prepare Oar without burning, so as to yield that Quantity of Plate it did by Quicksilver, as shall be shewn where the Refination by boiling is treated of.

C H A P. X.

*Whether the Oar ought to be burnt in the
Stone or in the Meal.*

THEY use to burn Oar in the Stone or in the Meal; and burning it in the Meal, they better understand the Nature of the Oar, for taking Care to stir it well about, and mix it equally in the Furnace, taking out a small Quantity, and putting Quicksilver and Salt thereunto in a short Space of Time, by the Disposition of the Quicksilver you shall quick-

ly know what the Oar is, whether it begin to grow like Lead or no, and whether the Lead be gross or fine, or whether there be need of more Materials or no, or whether to continue, or stop the burning of it, according as every Refiner by his own Experience hath found to succeed best with it out of that Oar which is burnt in the Stone, cannot be chosen this Equality, because the Force of the Fire cannot be equally communicated to Stones in a divers Situation and of different Bigness ; for it is clear that the small Stones are sooner heated than the greater, and those that are in the Centre of the Furnace, sooner than those that touch the Sides ; but this Manner of burning is subject to least damage, besides that it facilitates the grinding of the Oar.

It is a great Error to burn Oar already ground by Reverberation, because the Fierceness of the Fire burns the Sulphur or Betun which it contains, and suffer it not to discharge itself by little and little, but obligeth it to mingle itself with the Silver, and altogether to turn it into Dross ; moreover the Force of the Flame raises up the settled Parts of the Silver when they stir the Oar, and turning it into Smoak, blows it out of the Furnace. The most secure Way of burning Oar already ground, is to do it by a Tostadillo (or preserving Pan) made in the Fashion of a Furnace, as shall be directed hereafter, and because the Meal is wont by the Fire to gather into little Lumps, or else to grow spongy and gross, it is convenient to grind it over again, before it be incorporated ; the best Way of all has been said were to burn it in the Stone, because

cause it facilitates and saves a great Part of the grinding, and avoids the Inconvenience of the fine Silver flying away in the Smoak, and where the Oar is incorporated in hard Pebble and Flint, which are very untractable Stones, it is necessary to burn them. Other Sorts of Oar ought not to be burnt alone, but in Meal with the Mixture which shall be prescribed according to the ill Qualities where-with they are affected.

C H A P. XI.

Of Materials to be mixed with Oar, when they burn it.

IT is no extraordinary, but a common Thing for Iron to be engendered in the Gold and Silver Oar, and the Oar that is so affected is most difficult for burning or fundition either; it may be discovered by the Slowness of the Heat's Penetration into it, and also by a Loadstone, passing it over the Oar, after it is well burnt, and ground, which will snatch up the Iron, if there be any, and more or less of it, according to the Quantity mixed with the Oar. This Kind of Oar after it is ground, ought to be mixed with Sulphur, or which is better with the Meal of Oar that hath Sulphur, or Antimony in it, and in such Proportion as the Quantity of Iron in the Oar requires;

requires : when they are mingled, heat them upon the Tostadillo until that taking out some of the Meal, and ensaying it according to Custom, the Oar is found to be well conditioned. Sulphur is the Destruction of all Metals, Gold only excepted ; it hurts Tin less than other Metals, and Iron most of all, and that is the Reason why the Sulphur and Iron combating with, and destroying each other in the Furnace, the Silver is left alone by it's self. In like Manner is Oar cured that contains Sulphur or Antimony, being mingled and burnt with the Oar, or Dross of Iron after it is well ground.

That Oar which contains Orpiment, or Sandaraca, ought to be burnt with Soroches, which is Oar of Lead and Sulphur ; that which contains Betune black or white, must be burnt with Dross of Iron, and Powder of white Stones, whereof they make Lime : Besides, what hath been already said, the Diseases of Oar may be known by putting a little of it ground somewhat gross upon a red hot Plate of Iron, observing well what Fume it makes, which if it be white or black, participates of Betunes of that Colour ; if it were yellow, of Orpiment ; if red, of Sandaraca ; if it be yellow in the Middle, and green on the Outfides, of Sulphur ; and likewise the Earth that is drawn out of the Mines, together with the Oar, will oftentimes send forth Fumes of the like Kind of Colours.

C H A P. XII.

What the Refiner must do before he incorporates the Caxon.

TH'E Refiner thoroughly understanding what has been said before, the Oar being well ground and ceased with that Curiosity and Circumspection which is necessary (so that it need not be picked) before he doth go about to incorporate the Caxon, and before he burns the Meal, if there were need thereof, let him set apart three or four Pound of the Flower well mingled, and stirring it together again afresh, take a small Quantity, and make two Ensays thereof by melting in such Manner, as shall be shewed hereafter; whereby he shall certainly know what Silver the Caxon contains, and how much he may expect to get out of it. Laying down this Ground, that the Oar is of that they call *Pacos*, and needs not burning, nor contains Copperas, nor Coppaquiras, take out some in the Manner abovesaid, and Ensay a Pound of it by Quicksilver, but first pour upon the Oar a good deal of fair Water, more than is ordinarily necessary, and let it stand awhile, and if there arise a Scum, or Cream, that is gross, or oily, scum it off, and let that Water run out, and repeat the same with fresh Water, so often, until no such

such Scum arise, then take out so much Water as is superfluous, and put Salt and Quicksilver to it, and without any other Material proceed in repeating, to cast in those too, marking well the Operation of the Quicksilver, whether by accident it meets with more Quicksilver; whether it turns little or much to Lead, whether it dissolves or remains entire; if it fastens upon the Oar without the Help of any Material, it is a sign that the Oar do that tract it to itself: Repeat the Operation so, until you find that the Force of the Silver and the Repetition doth waste the Quicksilver, which if it do the Work is excellent, and will produce the Silver in dust as small as Pin-dust, which must be gotten together by searling, and the Remainder, which is mingled with Quicksilver, must be gotten by washing, and so you shall have all that the Oar contained, agreeable to the Experiment, which was made by melting. The Oar of *Berenguela de Pacages* is of the Quality aforementioned, a great deal whereof was spoiled at first, by working it with Materials, supposing it impossible there should be Oar, which did not stand in need thereof; now adays they refine with only Salt and Quicksilver, and get the same Quantity of Silver, as they did by melting, which is all that the Oar contains; this Oar is called *Cobrico*, if the Ensay doth shew Lead, for so they call it, when the Quicksilver loses it's own bright Colour, and looks like Lead, then other Materials are requisite to cleanse it, that it may the better take hold of, and gather the Silver together; those Materials that have this Virtue are Iron dissolved,

dissolved, Lead or Tin, and Lime slacked, or unslacked for some Resemblance it hath to Metal; any Oar may be refined with the Help of any one of these Materials, although that seems to be best, which is nearest of kindred to the Mixture of the Oar. If the Dust of the Silver, and Colour of the Quicksilver, be dusky and blackish, then Iron is most proper for it, for that which looks like Lead, Lead itself is best to that which is clear; Tin is the best for Quicksilver that looks as if it were guilt and hath Copper in it; Lime is the best. That Material which is most convenient, they throw in by little and little at a time, by Measure and Weight, until the Quicksilver look clear, and lay hold on the Silver, and by this they make the Account by the great, how much Materials they are to put into a Caxon or Chest, according to the Number of Quintals it contains.

If the Quicksilver be changed into white Powder or Ashes, and often passing it again through the Oar, do not make it finer, it proceeds from the Weight and Solidity of the Oar, the proper Accidents of those they call Soroches and Magagitas, and those other Oars that sparkle and have need of burning, as have been said before. Hard Stones that have no Silver in them, cause the same Accidents in Quicksilver, wherefore looking upon it, reduced to white Powder as aforesaid, if you do not discern either black Oar or Margagita amongst it, there was no Silver contained in that Oar which was ensaid, and is good for nothing.

If

If in the lesser Ensay, the Quicksilver be bright and entire, and falls to work, laying hold on the Silver, there is no need of using any other Material ; all Ensayes are made with a very little Quicksilver, that there may be room to use any other Materials, if there be Occasion for it, if not, that more Quicksilver may be added, and so the work of Refining performed with greater Brevity and Security, as shall be shewed hereafter ; and let not the Refiner cease making Experiments, until the lesser Ensay which he makes by Quicksilver, correspond with that which he makes by melting, and let him proceed respectively in the greater refining of the Caxones.

C H A P. XIII.

Continuing the Rules of the last Chapter, touching Oar that has need of burning.

IF the Oar have need of burning, as hath been said before, and the Ensayes by melting made, and the Refiner assured of the Quantity of Plate the Oar contains, let him burn it, observing the Rules of what he is to mix with it according to the Bigness of the Work, and the Convenience he hath to perform it in, but in no Case let him burn any

any Oar with Salt ; besides that it helps to calcine the Silver, it gives a stronger force to those ill Fumes which are in the Oar to penetrate into and spoil the Silver. One cannot well tell the set Number of Hours, wherein one ought to let Oar continue in the Fire, but the sure Rule to know when the Oar is well conditioned, is by ensaying some of the burnt Meal ; and if the Quicksilver remain intire and clear, and Silver sticking about it like driven Snow, then it is burnt enough, and the Fire continued, will certainly produce this Effect if the Oar be mingled with due Materials, and in a just Quantity ; in order to which, as also in the Oars they call Pacos, let them make lesser Ensayes to know what Quantity of Materials are to be put into the Furnace with every Quintal of Oar, but because these Ensayes are seldom made as they should be, let the following Rules be observed.

When the Oar in the Furnace leaves smelling ill, it is a Sign that it has discharged itself of all the Sulphur and Antimony that is in it ; when that Oar charged with Betune, and at the first coming into the Furnace, throwing out a thick and black Smoak by Degrees, sends forth a thinner and whiter Fume ; it shews that Inconvenience to be cured.

When Oar changes Colour, losing the sparkling that it had, and of *Negrillo* becoming *Paco*, it is a certain Sign that it is well disposed for the Quicksilver, although in this there be exceeding great Latitude.

That

That Oar which contains Copperas, if it be to be put in the Fire, must first be cleansed by washing in Meal, as hath been said, otherwise when it comes in the Furnace, it will become very red as may be seen if one burn Copperas alone in the Fire.

When Ensayng a little of the Meal burnt, the Quicksilver begins to look like Lead, it is a Sign that by the Heat of the Fire, the Copper, or Iron which the Metal contains (together with the Mixture of Sulphur) the Antimony or Margagita are turning into Copperas, and that the faster, the longer the Fire continues.

Take a Pound of the Meal out of the Furnace, whilst it is hot put it into a Vessel, and pour Water upon it three or four Fingers deep, then stir it a while, and let it settle, then if the Water turn white, or stain ones Nails, or change the Colour of the Tags of Points put thereinto, it is a Sign that the Silver calcineth and dissolves in the Water like Salt; save this Water in a glass Vessel, and pour more upon the Oar two or three times, or as often as is necessary, till it do not turn white; and all the Silver that was calcined, will be gotten out of the Oar; let the Water evaporate by a gentle Fire, and all the Plate will settle in the Bottom, and become fit for use by melting.

If the Water into which the hot Oar was put, gives no Signs of the Silver being calcined, dip polished Iron into it, and if it come out coloured like Copper, there is much Copperas in the Metal; wherefore wash the Metal in the Manner as hath been taught, until it be cleared

cleared of the Copperas, and change not the Colour of Iron; save the Waters of this Operation, for they are very useful in the refining Oar that have need of it, and if you should take out and melt the Sedement that is in the Bottom of that Water, fine Copper will be produced thereby, or Silver if any such have been calcined.

Ensay a little of the Oar, so disposed, by Quicksilver, as hath been said of the Oars Pacos, until by Experience you have found out the Way how to refine in greater Quantity, so that you may get as much Silver as you know that Oar contains by Ensay of melting in the Fire. Let nobody condemn these for tedious and unnecessary Curiosities, for there is nothing more profitable and important in these Matters, nor less commonly known; and by the Care and Pains of a few Days, the Refiner will be acquainted with the Sorts and Qualities of Oar that come to his Hand, and know how to proceed with them without wearying himself with making Ensay; but for all that hath been said, the Oar never comes to be perfectly refined, until the Silver little or much that it contained be purified and whitened in the Meal, and it is not impossible to put it in that Estate. Since the Oars Pacos of Lead may be reduced thereunto only by burning, and the Negrillos and others also that have Sulphur in them which stains and blacks the Silver, although it must be a long time in the Fire before it comes to this, and both one Sort of Oar and the other must have Boilings and Liquors often passed thro' them, which do cleanse and whiten the Silver,

ver, such as Millo, Allum, Salt and others, the Oar being in this Condition, needs no other Material but Quicksilver, which in less than four Days time will gather together all the Silver, and be very little consumed itself, because the short time of Operation, the Absence of ill Qualities, and the seldom times repassing it through the Oar, will not regrind, or disperse it to Powder, which is the principal Reason of the loss of Quicksilver, as shall be shewed hereafter.

C H A P. XIV.

Of the Nature of Quicksilver.

DEferring until another Occasion, which it may be in due time will offer itself to treat purposely of Quicksilver, and some Excrements thereof, of no less Profit than Curiosity; for the present, I shall only say with that Phoenix of Science in his intellectual Art, which all do follow, who treat of the hidden Philosophy of Metals, that Nature hath made this body of so uniform a Substance, and of Parts so perfectly united, that even the Fire, his greatest Enemy, as the Vulgar think, is not powerful enough by dividing to corrupt, and destroy it as it visibly doth all other Metals and Bodies in the World, except Gold and Silver. The Quicksilver retains it's whole intire Substance in the Fire,
if

if it be prepared on Purpose for it, which many Persons know how to do, or else all of it will fly quite away in the Form of Smoak, and meeting with any body that refreshes it; it will condense therein in it's own proper Form without being diminished one Hair, either in Weight or Quantity; neither also do the ill Qualities that are ordinarily found in Our corrupt Quick-silver in Veins wherein it is begotten, nor in the Chests wherein they refine, for although Copperas do dissolve it in that Manner that it seems to be consumed, and being sublimated in Copperas, and common Salt, it is transformed and turned into that which we call *Mercury*, that one would think it were totally destroyed and turned into another Species, yet it is not so, but all those Accidents have their Remedies, and it is neither impossible nor very difficult to quicken it again, and unite it, and in it's Place I shall shew how this is to be done.

CHAP.

C H A P. XV.

*Touching the Causes and Differences of that
which is called Lis.*

QUICKsilver dissolved, and divided into very subtile Parts, is commonly called by the Refiners *Lis*, which shews itself like an Eyebrow, in the Matter *Purunnia* when the Oar is enayed; and from it the experienced Refiners take their Indication of the Quality of the Oar and Condition of the Caxomes; it is caused by the often passing of it through the Oar (a Thing inexcusable in the ordinary Way of Refining) although it hath no ill Quality at all, but if it hath Copperas in it, it will grind the Quicksilver in great Extremity, as hath been said. If Quicksilver be without any foreign Impression upon it, and be dissolved into *Lis*, which is white, it is called *Lis* of Quicksilver; *Lis* of other Materials, is called that which is made by Quicksilver of Tin or Lead; and *Lis* of Silver is the fine and subtile Parts of Silver, made by the repassing of the Quicksilver through the Oar, but not as yet joined or incorporated with it; which when it is, they call by the Name of *Pella* (which signifies a Ball or Pellet). Quicksilver is susceptible of divers Colours, which appears in the *Lises* according to the different Matter which accompanies that Silver Oar
into

into which it is thrown; these Colours are reduced into three *Genuses* as it were, which comprehend under them several other Species.

Those three are *Cleer.*
Lead Coloured.
Spotted.

The Quicksilver looks cleer, either when the Oar hath no Silver at all in it, or when the Silver it contains is fine without any Alloy or Mixture; in that Case the Quicksilver will attract, and cloath itself with the Dust of fine Silver, without losing the Liveliness of it's Colour; which when it changeth, they call it leaden, for it's likeness unto the Colour of that Metal, although it always is accompanied with Signs that the Oar contains Silver, unless it be that the Lead, for so they call it, proceed from false Principles, and those have a manifest Cause, although little taken Notice of, as well as the other Proceedings in refining, which hitherunto have been governed by Chance. It is Copperas alone (the mortal Enemy of Quicksilver) which gives it the false Colour of Lead, in like Manner as it doth to other Metals the Colour of Copper; the other Lead Colour is a certain Sign of Silver, because ordinarily it is made in raw Oar, that is mixed with divers other bad Things, the which attracting to itself the Quicksilver; the Quicksilver lays hold of, and carries away both the Metal, and also it's bad Companions, who give it that strange Colour; this is the true Ground of what is treated

treated of in the 12th Chapt. of this Book, and the Reason of that Assertion, that the black or obscure *Lis*, or Colour of Quicksilver proceeds from Oar that is mixed with Iron; if the Quicksilver have a deep lead Colour, then it hath Lead itself in it's Company; if it be something more clear, then it hath Tin; and if it look as if it were guilt a little, Copper. Whether the *Lis* be of Quicksilver, Silver, or of other Materials is easy to be discerned; for the *Lis* of Quicksilver is very fine, white, but wanting Quickness, and when it falls together with the Water into the Tray, it doth not run up and down, but remains as if it stuck to the Bottom, and if you rub it with your Finger, it will unite into Lumps of Quicksilver. The *Lis* of Silver shines, and is like Pindust, or finer according to the Richness of the Oar, when they let the Water out from the Oar; it runs about the Bottom of the Tray, and if you rub it with your Finger, it will gather together into Pellets; the *Lis* of other Materials is as it were a middle Thing between the other two, and being reduced into a Body by rubbing it with one's Finger, it unites itself with the touched Quicksilver.

CHAP.

C H A P. XVI.

Whether it be fitting at first to put in all the Quicksilver, and the other Materials at once or no?

THE Oar being in good Disposition, and the Refiner by the foregoing Rules being assured how much Silver the Caxon contains, and what Proportion of Quicksilver and other Materials is necessary to be put in, so that when it comes to be washed, it may yield three Parts of Silver Pellets, and one of Quicksilver. It may be doubted whether all the Quicksilver and Materials aforesaid, should be put into the incorporating Vessel at once, or no : For the most Part, if not all the Artists of this Country did use to do it at once ; until about twenty Years ago. When I came to live in the Province of the *Lipes*, I persuaded them to the contrary, according to Rules, which I had learned in such like Operations, out of *Raimundus Lullus* ; which do evidently agree with the ordinary Course of Nature, that brings to Perfection all things by a slow and gentle Growth, and not suddenly nor violently. A very little Fire is sufficient to burn the whole World, if the

H combust-

combustible Matter were put into it by little and little, proportionable to the Force of the Fire; but if all that Matter, or an over-great Proportion of it should be laid upon the Fire at once, it would choak it, and put it out. The natural Heat of Animals is subject to the same Inconvenience, and the same happens proportionally unto the Chests of Metals: Besides that by Experience it is found, that the extraordinary Cold of much Quicksilver, doth accidentally bind up the Oar, and hinder the Refine, as on the contrary any Heat hastens it. Moreover, if because they have judged ill of the Remedy to be put into the Chest, the Caxon despair, and the Quicksilver dissolve, the Remedy will be the easier, the less loose the Caxon. And if there be need of using Tin or Lead, which cannot be applied without Quicksilver, that will be added with less Danger, the Quicksilver being in already. The same Damage or greater follows, when they exceed in the Quantity of Materials they put into the Oar which hath need thereof, because it dulls and deadens the Quicksilver, so that it will lay hold on no Silver at all, and can very hardly ever be reduced into that Condition it ought to be. After many Days spent in repassing the Quicksilver, and dressing of the Oar, let the Caxon be incorporated and washed with a third Part of Quicksilver at the most; and at first put in half the Tin or Lead, that is requisite to be spent, for so the Quicksilver will the better lay hold of the Plate, and draw it out presently before the Materials are consumed, which they call *Aplomar*: Whereby
will

will be avoided the Danger of the dry Plate, which, like Froth, swims upon the Water that comes out, and is the Occasion of much Mischief. If the Caxon stand in need thereof, proceed to put in more Quicksilver, and other Materials, always diminishing the Quantities proportionally in such manner, that it may go dry and not wet; for so there will be no Occasion for much *Lis*, and the Pellets themselves will serve to get out the rest of the Silver, whereby the Refining will be soonest and most securely performed. If it be needful to refine with Lime, the Rule already prescribed for Materials will not serve, but the Lime must be put in all at once; and with it repass the Caxon very well two or three Days before you put in the Quicksilver, taking especial Care that you do not put in too much of it; because it is the great Hinderance that the Quicksilver doth not lay hold of the greater Plate, and that is more hard to correct than other Materials.

C H A P. XVII.

Of the repeated passing the Quicksilver through the Oar and the Effects thereof.

THE chief and principal End of letting it soak through, is to divide the Quicksilver into several Bodies, that it may every where lay hold of the Plate ; also with that Motion it is heated, and better disposed for the Work : And last of all by that Friction, the Plate is cleansed and purified (which is that they call wasting the Materials :) All of them, Things most necessary and important, although they cause an unpardonable Damage, that hath been the loss of many Millions in the wasting and consumption of Quicksilver : For the Repassings have been the Foundation of this Inconvenience, by squeezing the Quicksilver through the grosser and finer Parts of the Meal into such little Atoms (which they call *Lis*) that scarce have Weight or Dimension ; which when they wash, the Caxon doth not fall down into the Tub at the Bottom ; but being over-drowned and mingled with the Lamas or Mud of the Meal, it stays and is cast away with them. This Inconvenience may be prevented by two Cautions ; the one is, that the first and second Day after the incorporating of the Meal of Oar in
the

the Caxon, they give not above two gentle Repassings, so that the Quicksilver may be divided, but not into too small Parcels; because before it hath gotten a good body of Silver, it is subject to part itself over finely. The Second is as abovesaid, that they put in the other Materials dry, and not wetted with Quicksilver, putting them in by little and little when it is most in the Proportion, one Part of Quicksilver to two of Pellets. Let nobody deceive themselves, for although the Meal in the Caxon contain other Materials sufficient, if it be much bathed with Quicksilver, that it shall be secured from the former Inconvenience; yet contrarywise it will rather be subject to a greater Prejudice, for of Necessity the Repassings will make *Lis*, and if it happen by some Accident, as it very well may, that the Materials be quite consumed; instead of the *Lis* made of them will remain only *Lis* of Quicksilver. In the *Lis* of Plate there is not that Danger, that by the often Repassings the Silver, should be wasted or consumed; rather it is thereby better refined, and better embraceth and uniteth itself with the Quicksilver.

C H A P. XVIII.

Of divers Accidents, which happen in the Way of Refining by Quicksilver, and their Remedies.

IN the Progress of this Kind of Refining, divers Accidents are met withal in the Caxons (or Chests full of Oar ground to be refined;) all which are discovered only by the Quicksilver, which as in a Glass represents the good, or ill Disposition of the Metals, which in themselves, by Reason of the Finess of the Meal into which they are ground, and a Mixture of Earth in the Oar, cannot be discerned.

If the Quicksilver be very much charged above what it ought with Materials, that is to say, Lead, Tin, Iron, or Lime (which the Spaniards call Quicksilver *Tocado*) it will not appear round but flatter'd, or rather prolonged like little Worms; and if you stir it about the Tray without Water, it will make Drops with little Tails, and stick to the Sides of the Tray. And when it is of this Condition, it is a Sign that it is killed, and it's Virtue obstructed from laying hold of the Silver. This Evil is remedied by much Repassing, not without great Cost and Expence of time: The quickest and most efficacious Remedy is Copperas, or the Water thereof, which

which I have shewed how to make and to keep in the Thirteenth Chapter of this Book : Put it into the Caxones at the same time as you do the Quicksilver, and other refining Materials more or less, according as there is Occasion, and you shall instantly see the Effect of it. The Reason whereof is plain, for (as hath been said) Copperas dissolved in Water converts the baser Metals into true Copper ; so that the Quality of Gold which they had before, and wherewith they choaked the Quicksilver, being turned into Heat (the Property of Copper) it is the Cause of reviving the Quicksilver : From hence is grounded the Practice of putting Copper ground small into the Caxon, which is found very profitable for the Purpose aforesaid : Hence also it comes to pass, that all Oar of Copper, although it be rich, is not proper to clear Quicksilver with, or to be used in the Refining to make it Aplomar, unless it have a great deal of Verdigrease or Copperas. The same Account may be given of the Virtue that is found in those they call Magistrates, which they use in the Refining to qualify the Caxones with Heat, and to make them Aplomar : Which Effect is produced from the burnt Copperas that is in it, as may be seen in their Composition, which for better Satisfaction I shall here set down.

Burn Oar or Copper, and grind it well ; then with an equal Quantity of Salt knead it into a body together, and having made it into Loaves, burn it again.

Others do mingle but one Part of Salt, with two Parts of Copper Oar, which they make up into a body and burn ; and to one Quintal

of that beaten to Powder, they add half a Pound of Filings of Latin.

Another Magistral is made of Lamas.

Relabes and Salt, an equal Portion of either soundly burnt together.

Another is made of that Oar wherewith they refine the Relabes and Salt put together in equal Portions.

Another Sort may be made of Copper Oar, Relabes, Meal of that Oar which is to be refined, dross of Iron and Salt, all put together in equal Portions and burnt in Loaves.

Another is made of three Parts of the Lamas burnt, and one Part of Salt. Every one inventing such like Compositions or Proportions, according to his own Fausy and Experience; the Foundation of all these Magistrales being the Copperas which the Fire produces in them, as may be seen and separated from them, by any who shall please to go about it, according to the Rules that have been already delivered: Which seems to confirm that which *Pliny* says, treating of Copper, namely, that it is begotten of Stones burnt.

These Magistrales are to be used with the same carefulness as hath been already said of the Materials; namely they are to be made trial of before the incorporating of the Caxon, that by these lesser Ensayes it may be known what Proportion is fit to be put into the Caxon, according to the Number of Quintals it shall contain; for if the Proportion do exceed, another great Inconvenience will be produced thereby, namely that which follows.

C H A P. XIX.

In prosecution of the Chapter foregoing.

AN Accident contrary to that mentioned in the former Chapter, and an Occasion of great waste of Quicksilver, is of the Colour of Lead; that is to say, when it is affected with no other Material Inconvenience, but only that of Discoloration; and the Damage is the greater, if the discolouring hath proceeded from Copperas, and that there be much Quicksilver divided, and running loose about. Quicksilver squeezed out of the Lumps, is very round and lively; if it be divided, the Parts of it, although never so small, do not run into a cylindrical Figure, but into a Spherical. This Mischief is cured by the contrary Materials, which as hath been said before, cleave unto the Quicksilver; nevertheless the Medicine, which by it's particular Qualities, Attraction, and natural Sympathy, cures this Evil, is Iron; which re-unites the Quicksilver, and gathers it together into a Body after it was dissolved, corrupted, and, in a Manner, turned into another Substance by the Copperas: Which shall be treated of more at large hereafter, when we speak of washing the Caxons.

No certain Rule can be given, what Quantity of Materials to put into the Caxons, that

have failed in the Operation ; because the Mischief and the Causes thereof are not always the same. But this general Rule must be observed, that they do not repass the Caxon with Quicksilver, till they have first ensayed a small Quantity thereof, and thereby have understood what is necessary. After that, let them take a third or a fourth Part of the Caxon, and mingle that with the whole Proportion of the Materials, and stir it well together, till it be very well mixed, and incorporated one with another ; then mix this with the rest of the Caxon, stir them very well together ; for after this Manner the Medicine will be best, and with most equality distributed in the Caxon : Especially if the Medicine to be put in, be very small in Quantity. Have a care to use the Means that is requisite to avoid falling into the first Inconvenience of overcharging the Quicksilver, and remedy the second Mischief with all possible Speed ; because otherwise the Copperas will transform the Quicksilver in such Manner, as if it were quite eaten up and consumed. When ensaying the Caxon, the Quicksilver is found in the Bottom of the *Purummia* Vessel, divided in small Grains not run together in a Lump, it is a Sign the Refination is imperfect, and that some little hairyness, or crisping encompasseth the Pellets of Quicksilver, and hinders them uniting. The Want of Materials is commonly the Cause of this, or else the over-much Alloy of other Metals, which as well as the Plate attracts the Quicksilver itself. Repassing, the Relabillo burnt, by Reason of it's sharp cutting Quality, is profitable to cleanse the Quick-

Quicksilver. Some put in Ashes, but the most proper and natural Remedy for it, is that which they call Millo or Allum, which makes the Silver white, and is very ordinarily to be had in great abundance amongst the Mines here at *Potosi*; and in *Guaico de Santiago* there is a Spring that runs continually with this Alum Water.

When the Caxon hath not been repassed equally, or not served with as much Quicksilver as is necessary, or in some Places doth not unite itself with other Parts of the Quicksilver, that had gotten Plate already, the Cause thereof is what they call dry Plate: In Ensayes you shall see it swim upon the Relaves crisped like Froth, and if it be not skimmed off, and saved before the cleansing the Caxon, it will swim at the top, and run away with the Lamas to the great Detriment of him that owns the Oar. If the Quicksilver be dry, having nevertheless Materials sufficient with it, it is no Inconvenience at all, because it will unite one with another the better, or else that Part which the Materials possessed, being wasted away, the other moist Parts remain in the Quicksilver to unite itself with the rest of the Pellets. That dry Plate which wants Materials, cannot safely be gathered together by loose Quicksilver, until the Caxon be ready for cleansing; the proper Remedy for this is to repass the Caxon with Pellets of Silver, not over small, so shall the dry Plate be collected together, and the greatest Part of the *Lis* also, if there were any there.

C H A P. XX.

How to know whether or no the Caxon be ready for washing.

THERE can no certain time be prefixed, wherein one is obliged to wash the Caxons. It's Maturity is hastened by frequent Repassings by the outward Heat of the Air, and the inward Heat of the Copper or Copperas, and other Things of that kind of Virtue, and such as clear and purify the Silver ; a principal Cause whereof is the burning of Metals. On the contrary, the Work of Refining is prolonged and slackened by fewer Repassings, if the Air be Cold or Frost, if the Caxon be over foul, that the Quicksilver loses it's clearness in passing through : But letting pass these, and other Accidents, let us come to the Point of gathering out the clear Silver mixed with Quicksilver, leaving the Earth behind, which is called washing the Caxon, whereunto no small Experience is necessary: For if the Caxon be not ripe for washing, that Plate which the Quicksilver hath not laid hold on, is likely to be utterly lost, or if it be not, it must be ground over again, so that at least one loses much time and Labour, and Silver too in the Repassings, besides other Hazards.

The Rules hitherto delivered for the Discovery of the Disposition of the Caxon are subject to very great Error; such as it's appearing so well to Sight as if there were need of no more Quicksilver; to find the *Lis* of the Plate all gathered together and finished, and that of the Quicksilver beginning to come; the Substance of the Plate, and Quicksilver being clear, and gilded as it were with other Signs, all of which do not secure the Judgment from being erroneous, because these may be produced by other Accidents besides the Maturity of the Caxon. The only sure and infallible Sign is to see whether the Quicksilver hath gotten all the Plate, which it ought to do according to the Proportion shewed by the lesser Ensay of Fire, which was made at the beginning, and if it hath not arrived to that, although it hath many more good Signs than hath been already mentioned, wash not the Caxon; but take more small Ensayes thereof, whereby you shall easily prove what Plate it contains, and what Remedy is necessary to bring it to full Perfection: Which when it is attained, and the refined Substance alone contains the aforefaid Proportion of Quicksilver and Pellet, strow some Quicksilver loose upon it, and therewith gently repass it two or three times in such Manner as it may go into the Copper better bathed, in the Proportion of three Parts Pellet, and two of Quicksilver: Or at least two of Pellet and one of Quicksilver. Then gather up some of the *Lis* that remains, and put it to the dry Plate, and to the whole Mass of Pellet, whereby they will be more weighty, and sink better to the Bottom.

tom of the Caldron, and will rise and waste less in the boiling. Throw Quicksilver also loose into the Caldron (which they call a Bath;) when it begins to be liquid, incorporate therewith that which the Caxon contained, and it will help to unite it the better ; and the more Quicksilver there was, the fewer Inequalities like Oyster shells will be produced.

C H A P. XXI.

That the washing of the Caxons causeth the loss and waste of Quicksilver.

AL L the Inconveniences that are and have been found in the Waste of Quicksilver, which they term either Loss or Consumption of it, are caused by the washing the Caxons : Until then nothing hath been lost ; however, one may be deceived in judging by the View even on Occasions, that have sometimes happened and may happen again ; that they find neither Quicksilver nor Pellet of incorporated Metal in the Caxon. For Accidents alone as hath been said, cannot alter the Quicksilver so as to corrupt and destroy it's Substance ; in the Caxon it is howsoever more or less disposed to get out imperceptibly with the Water or with the Lamas. The immediate Cause of this Mischief, is when the Quicksilver is made over thin without body or weight as it were ; so that it hath nothing to sink it

to

to the bottom of the Caldron ; and with the stirring the Caxon when they wash it, it mixeth itself with the Dregs and Dirt, and goes along with them, and there wants more or less of the Quicksilver which they put in at first, according to their better or worse stirring the Caxon and Quantity of *Lis*. It hath been a great Error in those, that because for so many Years the best Refiners in these Kingdoms have wasted at the least so much Quicksilver, as they have gotten Plate, therefore the Quicksilver is really and truly consumed in the Operation, not animadverting the Evidence to the contrary, which continually passeth through their Hands ; namely in the Lamas and Relics of the Caxon where the Quicksilver hath oftentimes staid behind, accompanied with a considerable Quantity of Plate : Which the Owners of Oar have experimented to their great Damage, and the Buyers and Refiners of the Relics of the Caxon to their great Profit and Advantage. Others speaking philosophically say, the Cause of the Consumption of the Quicksilver proceeds from the Contention and Combat, which it hath with contrary Qualities before it can lay hold on the Plate ; and that thereby it is debilitated and consumed. These Men say something to the Purpose, if they could demonstrate the contrary Qualities that are between Quicksilver and other Metals, between whom there is rather a great Sympathy and Agreement, Quicksilver being the principal whereof all other Metals are made, and also of the Minerals that ordinarily do accompany them ; but if these Men cannot prove the Cause, neither will the

the Effect which they suppose, namely the Destruction of Quicksilver follow: And there is certain Experience to the contrary, and hereafter shall be shewed a Way how to recover all the Quicksilver, even out of the Caxon, that is most spoiled in Operation, and so most difficult to do it in.

C H A P. XXII.

*The true Causes of the Loss of Quicksilver,
and their Remedies.*

THE Repassings are the remote Cause of wasting of the Quicksilver, which is thereby strained and divided into very small Parts which they call *Lis*: And although into whatsoever Oar, Earth or Sand, you throw Quicksilver, and repass it, you shall find the Effect aforesaid, yet it is most of all experimented in those Oars which are called Soroches; which by their Weight and glassy Quality, do more easily cut asunder and divide the Quicksilver into minute Parts.

Copperas is of it's own Nature a violent Cause of extenuating the Quicksilver, as hath been often said; and hath been the Cause of the waste of the greatest Part of the Quicksilver that hath been destroyed. There be other Causes, which accompany and assist the two former in working
this

this ill Effect: One is the Salt, which they use in refining, and wherewith they wash the Caxons, which every body knows thickens Water; whereby not only the small *Lis* of Quicksilver, but also heavier things swim and cannot sink to the bottom.

The Lamas which is mingled with the Water, and troubles it in the Caldron, thickens it, and doth yet more resist the sinking of the Quicksilver which stays and is thrown away together with it.

Lastly, the Motion of the Instrument wherewith they stir the Caxon when they wash it by condensing the Force of the Causes aforesaid, hinders the *Lis* from sinking, and croudeth it up to the top. The ordinary Repassings in this Way of Refining cannot be wholly excused in this Matter; but if the Rules already taught be carefully observed, the Damage will be the less. Likewise already hath been shewed the Way to clear Oar from the Copperas, and to clear the Margagita's from their heavy and glassy Qualities. Salt may be gotten out of the Caxons two several Ways, and preserved for Use to the saving of many Ducats a Year, now commonly spent in that Commodity. Put the Oar into Caxons made smooth and round on the Inside without Corners or Angles as is often used; let them stand a little sloping, only so much as is necessary, that all the Water may run to one Port of it; where there must be a Hole for it to run out at in convenient Season, but ordinarily kept stopp'd. When the Caxon is ready for washing, fill it with abundance of Water, opening and stirring about the Oar with the Hove, that
the

the Water may penetrate through it the better: And having done so a pretty while, open the Hole, and let the Water out into a Vessel provided on Purpose to receive it ; where it will either congeal into Salt, or remain in Liquor as it is, and will be serviceable for the Operation of other Caxons. Repeat this two or three times until the Water that comes out doth not taste brackish. If the Caxon was to have been washed in three Caldrons, wash it in six, whereby the Water will come out twice as clear, and with very little Mud or Sediment.

The Pestle wherewith they stir the Caxon, must not be used always in the same Hand, because the Circles going constantly parallel, the small Parts of the Quicksilver, and the dry Plate go along together with them; and never encounter one another to unite themselves into a bigger Body that they may sink to the Bottom. Wherefore after five or six turns with the right Hand, take as many more with the left, and so proceed; and because this cannot so conveniently be done in the ordinary washing Places, put into the Caldron a thing like a broad Peel, which opposite to the Course and Motion of the Pestle may disturb the March of the Quicksilver and dry Plate, and cause all the Content of the Vessel to meet and unite; excepting that which is at the Bottom, whereof there is no Necessity, because of the Bath which it is to suffer. Cover the Vessel with Plates of Copper, or Iron Quicksilvered, to which Side soever of the Vessel the *Lis* comes: It may stick thereunto, when the Caxon is washed; the *Lis* is easily gotten together

together, by sweeping the Sides of the Vessel with a Piece of Shoe Leather, a Piece of a Hat, or a Piece of Cloath.

C H A P. XXIII.

To make the Pine Apples, and to clear them of the Quicksilver.

HA V I N G taken the Plate and Quicksilver together out of the Caldron, and straining it through two coarse Clothes wetted, to make them the thicker; having beaten it also with a Battledoore to squeeze as much Quicksilver through the Clothes as is possible: Make Pine Apples of the dry Pellets in Moulds fitted for that Purpose; which are called Pine Apples from their Similitude to that Fruit by reason of their pyramidal Figure: And of those Pines that have been reasonably well strained, the fifth Part will be Silver, so that one hundred Pound of Pellers will produce twenty Pound Weight of Silver. The Pines that are made of richer Oar arise to less Profit than those that are made of poorer, because the Plate in the richer Oar is more coarse and spongy, than that which is contained in the poorer. In the straining of the Quicksilver though never so carefully, some small Parts of the Silver will go along with it, and the more in Quantity by how much the more Moisture there was in the Pellets when they began

began to strain them : The like whereof is seen in Water mixed with Clay, which although it be strained with never so much Care, will not look clear and pure, but muddy and troubled, by reason of it's Mixture with the Dirt; and the greater Quantity of Water there was, the more Dirt strains through along with it ; but letting it stand quietly a while, it will settle and gather itself together, and leave the Water clear. In like Manner, in the Vessels wherein they preserve the Quicksilver after they have done refining, and made the Pine Apples, after a few Days the Pellets of Silver will settle and gather into a body together. In the refining Work of *St Catharines* in the *Lipes* out of the Vessel, wherein they kept their Quicksilver, I saw as much Plate gotten of the Kind aforesaid, as would have made a great Pine Apple.

If the Quicksilver be heated, it becomes thinner, and will carry away more Silver in the Straining; also when the Pellets are strained, that are gotten by boiling, although it be done with very much Care, yet Plate will pass along with the Quicksilver ; and if you will let it stand a Days time to cool and settle, and strain it again, you will get more Pellets of Silver.

The Loss in clearing the Oar again from the Quicksilver hath been great and irrecoverable, as may be guessed from the Experiment thereof in this imperial City at this present, when the trading in Metals runs but low : And yet *communibus annis* above thirty thousand Pieces of Eight are wasted by the Expence of Quicksilver. How vast a Sum then hath

hath been spent by Quicksilver, in the many other very rich Mines belonging to this Kingdom. This Inconvenience hath proceeded from want of Care in seeing that the Canones and Caperucas (which are the Names of the Vessels they use in the recovering the Quick-silver) be made of very good Stuff, and shut curiously close in the Place where they join together. The Clay whereof usually they are made is very spongy and full of Pores, so that the Water soaks through and sweats out at them; then it is no Wonder that the Quick-silver attenuated by the Violence of the Fire (which widens the Pores of the Vessel also) evaporates through the same, and is exhaled and lost. To say that any Part of the Quicksilver is destroyed or perisheth by the Heat of the Fire is only the Imagination of those that understand not the Uniformity of it's Substance, as hath been shewed before. Make the Caperucas and Canones of such Stuff as you make the Crucibles, and that Inconvenience will cease, and the Vessels will last for ever (because they are so mightily condensed and resist the Fire) unless some accidental Blow or Knock do break them. In that noble Town of *St Philippi of Austria, Oruro*, famous for Abundance of Mines both of Gold and Silver, on the Top of a little Hill which stands above the Church of the *Ranqueria*, there is a little Vein of white Earth, whereof they make Vessels for Use, which after they are baked become so close and firm that they are not inferior to the best *China*. I was the first that made trial
and

and published the Usefulness of it for the making of Crucibles with very good Success to those that had need of them. And I do not doubt but there is such Kind of Earth about this City of *Potosi*, where nothing hath been found wanting that any wise belonged to the obtaining or refining of that Abundance of Riches, which Nature hath bestowed upon it : Although hitherunto much Business, and a short Time of abode here, hath hindered me from finding of it out. But where such Kind of Earth is wanting, mingle the Clay, whereof you make these Vessels, the better with the Scum or Dross of Iron ground very fine, and make it up and bake it very well ; and there shall not be so much Quicksilver lost in the Use of them as is by those now in common Use. The Canones must be glaz'd on the Inside, the Caperucas not ; because the violent Heat will melt the Glazing, and make it run.

CHAP. XXIV.

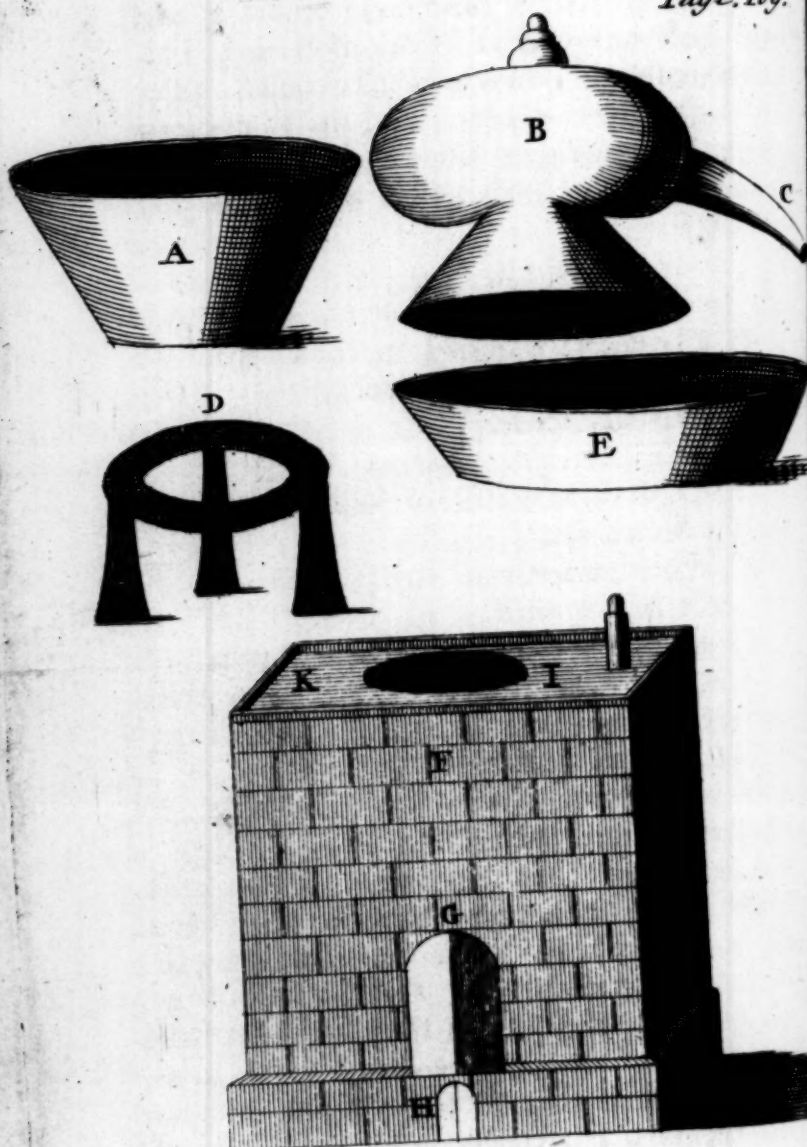
Other safer Ways of clearing the Pine Apples from Quick-Silver.

THE best Vessels for this Purpose are made of Iron or Copper beaten to the Thickness of a Piece of Eight, or somewhat thinner; and for more Security, that the Vessels may the better endure the Fire, they cover the Copper Vessel with a Coat of good earthen Ware on the outside. Not many Years ago, some People began to use these Copper Vessels cased with earthen Ware, and left them off again, because they understood not the Nature of them, nor how to use them. The like happened in the Province of the *Chickas*, which cased their refining Vessels as above said, because they heard that in their Neighbourhood in the *Lipes*, I was working after that Manner. The Cause of these Mistakes shall be shewed in the Discourse which follows.

The shortest, best, and most secure Way of clearing the Pine Apples from Quicksilver is in this Manner. Make a deep Vessel of Iron wider at the Top than at the Bottom, containing more or less according to the Quantity of Metal intended to be cleared at one Time: Set it upon a Trevet of strong earthen

earthen Ware, or of Iron cased with Earth in a Furnace of sufficient Bigness to put Wood or Coals under it, as Occasion shall require at a Mouth made for that Purpose. The Rest of that Furnace both the Top, Bottom, and Sides is to be very close; excepting one little Hole at the Top where it shall be found most convenient to give Respiration. Dispose the Vessel aforesaid in such Manner as they do that which they call the Cannon in the ordinary Way of using Quicksilver; so that it may look out above the Top of the Furnace one large Finger's Breadth or two, that it may the better join with another Vessel to be put a-top of it, which may serve instead of the Caperuca. Put the Pellet (or Mettle aforesaid) well kneaded together in Cakes of what Form you please into the Vessel, and lest the Plate should melt and stick to the Iron Vessel, let it have a thin Coat on the Inside of earthen Ware; or such as Crucibles are made of. Cover this Vessel with a large Limbeck Head made of hammer'd Iron, or Copper, or of very good earthen Ware well glaz'd; and out of it draw a long Pipe a little sloping, the Cavity whereof in the narrowest Place, namely the Extremity, let be no lesser, than the Bigness of one's little Finger. Let the joining of the Limbeck with the Vessel below it, be stopped very close with Galt; then in a secure Place, that doth not feel the Heat of the Furnace, let there be placed a great Vessel of Stone or of other Matter full of cold Water; whereinto let the Nose of the Limbeck enter two Finger's Breadth. Blow up the Fire in the Furnace,
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from which the Quicksilver flying in the Form of Vapours to the Top of the Limbeck, the Coolness thereof presently reduceth it into a Body again, which runs down through the Nose into the Vessel of Water aforesaid. The Limbeck should now and then be cooled on the Outside with wet Clothes, and the Water into which the Quicksilver falls as it becomes warm should have more fresh Water added to it.

Here place the Cut.

- A. The deep Vessel of Iron, or Copper.
- B. The Head of the Limbeck.
- C. The Nose of it.
- D. A Trevet.
- E. A Basin or Vessel of Water to receive the Quicksilver in.
- F. The Furnace.
- G. the Mouth of it.
- H. The Hole to draw out the Ashes at.
- I. A Hole open at the Top of the Furnace, whereat the deep Iron Vessel looks out a little, and is joined to the Limbeck.
- K. Is a Chimney to let out Smoak, and give Respiration to the Fire.

The Trouble and Hazard of keeping them close in the Joint with Clay or Galt, may be excused, by making the Place where they shut one upon the other a Handful and a half higher; or if to that Size of them, that is now in use, they put at the Bottom on the Outside, and fill it two Fingers broad, so that the lower Vessel may come up very close upon it, and cannot enter further into it. A little lower than

than the Caperucas come, are placed the Candlestick-Foot, as they call it, whereupon they set the Plate and the Pine-Apple. The Candlestick-Foot comes up about four Fingers higher than the Mouth of the lower Vessel, which they call the Cannon; in the which, on the one Side, four or six Fingers lower than the Fire used to be, enters in a small Pipe of cold Water, at a Hole made for that Purpose in the Cannon, without disturbing the Caperuca at all, because it is not to go in strait, but with a little Liberty. Over against this Hole there is such another, out of which runs as much Water as enters in at the former, whereby the Cannon is always kept full, and the Water in good Temper to receive the Quicksilver without any Prejudice.

If one separates the Quicksilver by the Limbeck, they may do the same thing, clapping a Ring of Copper of two Fingers breadth, and other two Fingers deep, to the Mouth of the lower Vessel; so that the other Vessel may easily be let in and out, wherein the Quicksilver is to be saved. Into this Circle the Limbeck must be fitted, and, to prevent it's being blown off with the Force of the Vapour of the Quicksilver, the Limbeck must be kept down with Weight on the Top of it, or tying it to some other fixed Thing; or making a Ring on the Top of the Limbeck, pass a Bar of Iron through it, both Ends whereof afterwards remaining fixed in two Walls built on each Side of it for that Purpose.

*The End of the Second Book of ALONSO
BARBA's Art of Metals.*

A
DISCOVERY
OF
Subterranean Treasure;

VIZ.

Of all Manner of MINES and MINERALS, from the *Gold* to the *Coal*; with plain Directions and Rules for the finding of them in all Kingdoms and Countries.

And also,

The Art of Melting, Refining, and Assaying of them is plainly shewn; so that every Man of an ordinary Capacity may, with a small Charge, presently try the Value of such Oars as shall be found either by Rule or by Accident.

To which is added,

A real Experiment, whereby every one may presently try whether any Piece of Gold that shall come to his Hands be true or counterfeit, without defacing or altering the Form thereof, and more certainly than any Goldsmith or Refiner whatsoever can do.

ALSO

A perfect Way to try what Colour any Berry, Leaf, Flower, Stalk, Root, Fruit, Seed, Bark, or Wood will give; with an infallible Method of preparing Colours, which shall neither stain, nor fade, like ordinary Colours.

Very necessary for every one to know, whether he travels by Land or Sea, or in whatsoever Country, Dominion, or Plantation he may reside.

The Whole founded on the Experience of
Mr GABRIEL PLATTES.

LONDON,

Printed for OLIVE PAYNE, at *Horace's Head* in *Round-Court* in the *Strand*. MDCCXXXVIII.

DISCOVERY

OF

Subterranean Treasures;

Of all Manner of Minerals and
 Metals, from the Gold to the
 Lead, with plain Directions and Rules
 for the finding of them in all King-
 doms and Counties.



And also
 The Art of Melting, Refining, and Assaying
 of them is plainly shew'd; so that
 Man of an ordinary Capacity may win
 small Charge, presently try the Value of
 such Minerals, shall be found either by Rule
 or by Accident. I have also added
 a Table to which is annexed
 A full Hypothesis, whereby every one may presently
 try whether any Piece of Gold that he comes to his Hands
 is pure or counterfeit, without observing or using the
 usual Assays, and more certainly than any Goldsmith or
 Jeweller can do.

ALSO

A perfect Way to try what Colour any Battery Lead
 is of, Silver, Brass, Copper, Iron, Steel, Bar, or Lead will
 give, with an excellent Method of trying of them, which
 shall not fail, nor take the ordinary Assays.
 And a new Method for everyone to know, whether he has any
 Lead or Steel, or a Silver or Copper, or Brass,
 or any other Metal, by the

The Whole founded on the Experiments of
 MR. CARRIET PLATT.

LONDON,

Printed for O. & P. at Henry's Head in
 Fleet-Street in the Strand, MDCCLXXVII.



TO THE READER.

WHEREAS diverse Reasons have joined together to move me to take in hand this Task, I will declare some few of those that may give the best Satisfaction to the Reader, in this Manner following. First, when I considered the great Number of Treasure and Riches which lieth hidden in the Belly of the Earth, and doth no Good at all; and also the great Benefit which might accrue to diverse Kingdoms and Countries, by setting People to Work, not only in the discovering them, but also in the several Operations about the Digging, Melting, and Refining of them; also when I

TO the READER.

considered that the most Part of the Mines hitherto discovered have come by mere Accident, I thought that I could not be better employed, than to give Rules and Directions for the same. For though it is not impossible, that if two Men be sent to seek a Thing that is lost, and one of them be hoodwink'd, and the other have the Use and Benefit of his Eyes, yet the Person hoodwink'd may casually stumble upon it; nevertheless it is twenty to one that the other should have found it before him. So in this Case, I dare hazard a Wager of twenty to one, that there will be more good Mines discovered within seven Years after the divulging of these Rules and Directions, than hath been in twenty-seven Years before. Also when I considered that many Minerals found out by Accident hath come to no Good, by reason of the Distance of Place from Refiners, and Men of Judgment and Experience; for that the Finders thereof were loath to come so far, and spend so much Money upon an Uncertainty, as the Trial thereof would require, I thought I could not do a better Deed, than to shew the Manner of such Trials, in such plain Manner, that every Man may try the same in his Shop, or Chimney Corner, with little Cost and Labour.

And
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TO the READER.

And the Truth of this I can witness by Experience; for when I was a Youth, and had no Skill in these Affairs, I happened upon a Mineral fair to see to, and could find no Man nearer than an hundred Miles which could inform me of the true Value thereof; whereupon, rather than to be at such Charges as the Trial required, I suffered the same to be neglected.

And though that the Rules and Directions given in this Book be exquisite, and give strong Signs of Metals and Minerals, yet I would be loath that any Man should be thereby animated to take in hand great Voyages, and consume his Estate in the Pursuit of this Design, deeming them to be impossible ever to fail, but rather to make this a Part of his Business, when he shall come to such Places as yield strong Probabilities.

And so far I am from envying the former Ways in finding them by accident, that I have partly taken this Pains, that those which shall hereafter be found by accident may not be neglected, as I conjecture, that many have been by my own formerly mentioned.

For I could wish that many Men had the like Fortune that one had, who in the climbing up of the great Mountain Potosi, in the Kingdom

'To the READER.

*Kingdom of Peru in the West-Indies, took
hold of a young Tree to stay himself withal,
and thereby plucked it up by the Roots,
whereunto there did adhere good Silver Oar;
which being tried, and found rich, hath ever
since been wrought upon, and innumerable
Treasure and Riches have therebence been
digged, to the Value of many hundred Mil-
lions of Pounds Sterling.*

Your hearty Well-wisher,

G. P.



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DISCOVERY

Of all SORTS of
Mines, Minerals, &c.

CHAP. I.

*Wherein is demonstrated the natural Cause
of the Generation and Production of
Mountains and Metals; whereby the
Seekers may obtain a good competent Mea-
sure of Knowledge to guide them where to
seek for the other Eternal Signs,*



SOLOMON saith, that Hope
deferred breaks the Heart; but
the Desire obtained, is a Tree
of Life: If Hope only deferred
break the Heart, then Hope
frustrated must needs break it a great deal
more.

To

To the End therefore that our Hope may not be too frequently frustrated, I will first declare the Places where there is no Probability to find out Metals, and afterwards I will shew where there is strong Probability: And then in the next Chapter I will shew how to go about the Work, to find out the strong Signs which may rightly guide the Seekers to obtain their Desire.

And first, there is no Probability that any Metals can be generated near unto the North and South Poles of the Globe, for those can by no Means have any convenient Matrix for such a Generation, being by all Probabilities nothing but two Islands of Ice; for if they were any Thing else the Course of Nature must needs alter, and change, and run presently out of Order.

For as there is in the burning Zones a continual Exhalation of Water, and rarifying of the same into Air: So there must needs be in the North and South a continual Condensation of Air into Water to supply the same again, else the Motion cannot be perpetually circular.

Now whereas the North and South Parts, by Reason of their Coldness, cannot suffer the said condensed Meteors to descend in Form of Water, but in the Form of Snow, Hail, or some Substance of like Nature, which there cannot melt in the Superficies for Want of Heat, it is very probable that the new Accretion this Way produced, doth press down still with it's Weight the said Islands of Ice towards the Center, where the central Heat melteth it off continually, by which Means

the spherical Form of both Earth and Water are perpetually preserved.

And if any Man be of a contrary Opinion, I will not envy him; but as for my own Part, I will sell my Interest and Hope of Metals in those Places for a Farthing, although I had a Device that the Cold there could not prevent my seeking for them.

Also in Vallies and plain Champain Countries, there is no Hope to prosper in this Design, for the Womb of such Earth is not apt for such a Generation, the Reasons whereof will presently follow.

Now that we have left us no other Places to seek in but the rocky Mountains, I will spend the rest of this Chapter in demonstrating the natural Cause of the Generation of Rocks, Mountains, and Metals, and so proceed forward.

And first, I will set down the Opinion of others with their Confutation; and lastly, the Confirmation of my own Opinion by irrefragable Demonstration.

Some have thought that the mighty Creator made the vast, deformed, and craggy Rocks and Mountains in the Beginning. But this appeareth to be an Opinion, whereby great Dishonour may reflect upon the Creator, who besides his Omnipotent Power, doth continually make use of his admirable Wisdom, and exquisite Artifice in all his Works, and made nothing deformed or unfit for the use for which it was created: Now the Earth being ordained to bear Fruits for the Use of Man, and Rocks are not fit for that Purpose, it

it plainly appeareth that they came not by Accident.

Some others have thought that they came by Accident, but yet that they were produced by Accreation in Length of Time, even as Warts, Tumours, Wenns, and Excrefcences are engendred in the Superficies of Mens Bodies: And of this Opinion I myfelf was in my Minority, till fuch Time as by practical Experience I found out a more probable Opinion.

Now for a plain Demonftration, let this Experiment following be tried, and I make no Queftion, but that it will fatisfy every one that hath an inquisitive Difpofition.

Let there be had a great Retort of Glafs, and let the fame be half filled with Brimftone, Sea coal, and as many bituminous and fulphurous fubteraneal Subftances as can be had: Then fill the Neck thereof half full with the moft free Earth from Stones that can be found, but thruft it not in too hard, then let it be luted, and fet in an open Furnace to diftil with a temperate Fire, which may only kindle the faid Subftances, and if you work exquisitely, you fhall find the faid Earth petrefied, and turned into a Stone: you fhall alfo find Cracks and Chinks in it, filled with the moft tenacious, clammy, and vifcuous Parts of the faid Vapours, which afcended from the fubteraneal combuftible Subftances.

Whereby it appeareth that the fame Thing is done by Nature, and that the Rocks and craggy Mountains are caufed by the Vapours of bituminous and fulphurous Subftances kindled in the Bowels of the Earth, of which

there be divers so well known, that they need not be here mentioned : Also it appeareth that the Veins of Metals are engendered in the Cracks and Crannies of the said Mountains, out of the most clammy and glutenous part of the said Vapours there adhering, where the Cold gave them leave to be congealed and condensed.

Now concerning the Exaltation of the Mountains above the Vallies, it appeareth to come to pass by the Water in former times, whose Property is to wear away by it's Motion the most loose earth, and to leave the more firm Ground, and rocky places highest ; but whether this was done by *Noah's Flood*, or by the Sea in former Ages, is doubted. As for my Opinion, I refer the Reader to my Book formerly mentioned, and if any Man be in Doubt of this, let him take the Stone formerly made by Art, and place it so, that the Motion of the Water may work upon it, and you shall find it worn most in the loosest Places, and least in the more firm compacted Places ; thereby shewing the natural Cause of Mountains and Vallies. Also if a River should be turned out of it's Course, and the Bottom thereof accurately considered upon, how the Water by it's Motion hath worn away the Earth most in the loosest Earth, and least in that which is more firm, it doth evidently demonstrate the natural Cause of Hills and Vallies, and the Unevenness of the Earth caused by the Motion of the Sea in former Ages.

C H A P. II.

Wherein is shewn the Signs of Mines and Minerals, with the Manner how to work to find the same.

WHEN we come to the rocky and craggy Mountains, the first thing we are to observe, is the Barrenness of them ; for the more barren they are, the greater Probability there is that they contain rich Mines and Minerals.

The next Work is to find out the Springs of Water issuing out of the said Mountains, and those being found, a Quantity of the said Water is to be boiled in a new clean Pipkin, to the Consistency of thin Oyl, but not so thick as a Sirrup, and when it is almost cold, then to put in an Urinal, and to set it in the coldest Place that can be found for three Days, then to play the Physician, and to observe it exquisitely what Residence it yieldeth : If nothing settle but a black Earth or Mudd, it is a Sign of Coals : if some Part thereof shoot into Ice, or a Substance like Ice or Vitriol, then to observe the Colour thereof ; if it be green or blewish, it is an evident Sign of Copper ; if whitish, then it may signify any other Metal without Exception.

The next Work is to go to the bare Rocks, and there to find out the Clifts, Cracks, and Crannies; this done, to go to the Top, or till you find some Grass growing right upon the Top of the said Crannies; and then to observe diligently the kind of that Grass, and how it differeth from other Grass, ordinarily growing in the same Mountain; not only in Form, but also in Colour, which Colour sheweth the greatest Difference in the Heat of Summer; for the subterranean Vapours issuing out of the Orifice of Mines differ from those which issue out of more solid Places of the Mountains.

The next Work is to see if there be any Marcasites to be found in the Superficies of the said Mountains; which though they are usually of divers Colours, and seldom good for any thing, yet they are strong Signs of Minerals within, being themselves the Spume and Froth of the better Metals, breathed forth, even as Drink breatheth up it's Yest or Froth to the Superficies.

And if they be put in an ordinary Fire, they will turn black, and yield a Smell of *Brimstone, Arsenic, Antimony*, or some other thing, commonly called or known by the Name of a *middle Mineral*.

The next Work is to try the Operation with the *Virgula divina*, as beneath is declared; and where it sheweth the strongest Signs, as is likewise beneath taught, and also the Place is most accompany'd with the other Signs formerly mentioned; there, by digging or boaring, try your Fortunes.

The Operation with the *Virgula divina* is thus to be performed: Some observe a set
 311 Day

Day and Hour, with certain Words and Ceremonies at the cutting up of the same, which I have found to be little to the Purpose. Thus I wrought about Midsummer, in a calm Morning: I cut up a Rod of Hasel, all of the same Spring's Growth, almost a Yard long; then I ty'd it to my Staff, in the middle, with a strong Thread, so that it did hang even, like the Beam of a Balance: thus I carry'd it up and down the Mountains where Lead grewed, and before Noon it guided me to the Orifice of a Lead-mine, which I try'd, having one with me with an hacket of Iron and a Spade; and within two Hours we found a Vein of Lead Oar, within less than a Foot of the Grass: The Signs that it sheweth is to bow down the Root-end towards the Earth, as though it would grow there, near unto the Orifice of a Mine; when you see it does so, you must carry it round about the place, to see that it turneth in the String still to the same Place, on which Side soever you stand.

The Reason of this Attraction I conceived to be of Kin to the Load-stone, drawing Iron to it by a secret Virtue, inbred by Nature, and not by any Conjurat[i]on, as some have fondly imagin'd.

And the Reason of this my Opinion was, because that in divers of my practical Experiments I have observed an Attraction betwixt several things, like that of the Load-stone and Iron; and if it were to good Purpose, I suppose that I could shew more Experience of that Kind than any Man in *England*.

Now in the new Plantations, as *New-England, Virginia, Bermudas, &c.* where it is like that few or none have ever try'd, that had any Skill in these Affairs, it is very probable that the Orifice of divers Mines may be discerned with the Eye in the Clifts of the Rocks in many Places, as some have been in *England* at the first, before that Men grew a little skilful, and these to be lost and neglected, were a Shame to the Planters; for these Mines if they prove rich, would yield more gain in one Year, than their Tobacco, and such Trifles would yield in their whole Lives.

CHAP. III.

Now that we are come to the melting and refining of Metals, I will begin first with the Oar of Lead, because that is one of the most common Metals found in these Northern Countries.

THE first Work therefore to be done, is to have a little Grate of Iron about a Foot broad, like such as are used in a Still to make the Fire upon: This is to be placed in your Chimney-corner with loose Bricks, one Thickness underneath, and empty in the Middle, to give Air to the Fire; then lay more Bricks above four Course high, round about

about, and if they be laid without Morter, the Fire will burn the better ; then fill it with Char-coals kindled, in the midst whereof set your Melting-pot, with one Pound of Lead-ore, and four Ounces of Filings of Iron mingled together, and so blow to it strongly with a pair of good Hand-bellows, till it be well melted down ; then let the Pot be taken out with a pair of Tongs, and set to cool ; when it is cold, break it, and knock off the brittle Cinder lying upon the Top of the Metal with an Hammer, till none be left but the malleable Metal, which you may assay and refine in the Manner following : Take a little Test made as beneath, and place it in the middle of your Chimney ; lay Ashes about it, about six Inches broad, and as high, or rather higher than your Test ; lay Bricks about the Ashes to hold them up one Brick Thickness, and two Bricks broad, then lay about half a Peck of Char-coals upon the Test kindled, and when they are almost consumed, and the Test red hot, put them by a little in the midst over the Test, and lay over a piece of good Oak-wood about five Inches square, and eighteen Inches long ; lay it so upon two Tyle-sheards, that it may lie about an Inch and an half above the Test, then lay on more ordinary Billets and some Char-coals amongst ; make the Fire about it so strong as to roast a Pig, then blow to it a little, till the Fire burn clear, then put upon the Test two Ounces of your Lead, and blow to it gently, and in three quarters of an Hour, all the Lead will be consumed, and the Silver will

will lie in the middle of the Test like a little Bead or Pearl; then put aside the Fire, and let all be cold.

Then you may weigh the Silver in a pair of Gold-scales, and so cast it up how much there is in a Tun of Lead. I have thus try'd many Oars, and have found them to differ in Goodness of all Sorts, from forty Shillings worth worth of Silver in a Tun to thirty five Pounds worth of Silver in a Tun, and there is no Lead but it holdeth some Silver, yet it is not worth the Refining, unless it yield eight or ten Pound upon a Tun at least.

The Test may thus be made: First, let a Smith make a Ring of Iron about four Inches wide, and two Inches deep, and a quarter of an Inch thick, and as wide above as beneath, and without a Bottom.

Then burn Mutton and Beef-bones in the Fire till they be white; then beat them small in a Morter, and searce them fine like Meal; then with a little Beer or Water temper a small Part thereof like Pap, then put so much more of the dry Powder by little and little, as will make it so stiff that it will be made into a Ball, but remain clammish, betwixt Powder and Paste; then with a Pestle stamp it gently into your Ring till it be Top-full, being set upon an even Board, then stamp it a little lower in the Middle, then at the Edges, and smooth it with a slight Stone, or some round Glass, so set it in the Chimney Corner, to dry a Day or two, and it is ready for your Work.

If you put a quarter of an Ounce of Sandivert, and as much Salt-petre mingled together

ther with your Powder of Lead, and Filings of Iron at your first melting, it will melt somewhat sooner, and with less blowing, besides that the Cinder will part cleaner from the malleable Metal.

And if you want Char-coals, you may burn Wood in an Oven, and when it is red, and hath done smoaking, you may set up the Oven-lid, and damp it.

Or you may do the like in an open Chimney, and damp it in an earthen Pot, or cover it with Ashes; or damp it in a Hole in the Ground, by covering it with a Cover, or with Ashes.

Any of these Coals will serve to make your Assays and Trials. As for Directions for great Works here is nothing intended in this little Book; but only to be sure whether the Work will quit the Cost; which if it will, then Provision for great Works will easily be brought to pass.

And if you want Pots, you may be at choice, whether you will buy the same at the Goldsmiths, or Potters in *London*, who sell *Flanders* Melting-pots, or make them yourself by this Direction following:

Take right *Flanders* Juggs, such as they usually put Bottle-beer in, beat them to fine Powder, and searce them fine as Meal; take of this Meal four Pound, of the fine Powder of *Tobacco*-pipe Clay one Pound, temper them together with the red faitish Water, that issueth out of an Horse Dunghil, beat it strongly upon a broad Board with a Rowling-pin, till it be stiff Paste, then fashion your Pots upon a piece of Wood, turned like a Top, only
let

let the sharp End of the Top be thicker and flatter than an ordinary Top ; then set them to dry in your Chimney Corner a Day or two ; when you use them, set them in the Fire at the first kindling ; and so let the Fire steal upon them till they be red hot ; then put in your Metal and Ingredients, and cover it with a Tile-sheard, or cover of Iron, and so melt it down.

C H A P. IV.

Wherein is shewed the Operations of Tin.

THIS Metal may be melted down like the Lead, only omitting the Filings of Iron ; but when it is melted it is not malleable, till it be compounded with certain Proportions of other Metals, which I will not declare, because it is a Secret of Weight belonging to the Pewterers Trade.

And as for refining of it, I am sure it cannot be done by any Artifice ; for I suppose that I have try'd more Experiments about it, than any ten Men in *England*, because that I saw the Refiners could not do it ; therefore I took the more Pains and Industry to bring it to pass ; which if I could have affected, I do verily believe it would have proved a rich Metal ; but the more I try'd the worse I speed, for at the last I melted Gold and Silver equal parts with the Tin, thinking thereby

thereby to bring it down into the Lead, and to make it to drive fair, and refine kindly, but all was vain, for the Tin poysoned and consum'd some of my rich Metals.

Now as there is no Hopes of any Royal Metal ever to be gotten out of this Mineral; to supply the Shortness of this Chapter, I will shew a Way, how every one that hath a mind to meddle with these Affairs, may have good possibility to enrich themselves and their Posterity; and be out of Danger to undo themselves, or to damnify themselves in any Manner of Value that is considerable.

For my Meaning is, in the taking in hand of this Task, to do Good to all, and Hurt to none; and that no Man from henceforth shall need to be at a quarter of Charge, Study, or Labour, which I myself have undergone.

Therefore seeing that if the most ingenious and exquisite Ways be taken in the Design that Wit can attain unto, yet it is but an Adventure; for sometimes all the Labour may be lost, though not often, if good Heed be taken; and sometimes Mines may be found, which will not quit the Charges to be wrought upon.

Therefore, as wise Merchants will not hazard all in one Bottom, so let this never be any Man's Design totally; for now there is no such need but they may do all that can be done at such spare Times, as any Gentleman, or Man of Quality, usually spendeth in Hawking, Hunting, Gaming, or other Pleasures; whereof he needs but set a part of that Time for these Purposes; having the most part of his Work done to his Hands in this little Book.

If

If the Refiners shall grudge at me, for disclosing some of the Secrets of their Trade, I will answer them in this Manner: First, I myself have spent the Time of divers Apprentisships in these Affairs, and therefore claim a Privilege to disclose my Experience for the public Benefits at my Pleasure.

Secondly, I affirm, that there can be no Damage to any Refiner, by the divulging of these Secrets; but on the contrary, a great Probability of much Gain to that Trade; for that, here is nothing but the Skill to make the Assays disclosed for the Searcher's Satisfaction, before he take in hand great Works; which if he find Cause so to do, I advise him to chuse the best Workmen that he can get, and one that hath been long experienced in these Works and in so doing he shall prosper the better in his Design: and if every Year some increase of that Trade shall be entertained in these Affairs, as there is good Probability they may; the rest will have Cause to give me Thanks for my Pains, rather than opprobrious Speeches.

C H A P. V.

Wherein is shewed the Operation of Iron.

AS for the melting hereof, seeing that it is no Work to be done in the Chimney Corner, I will turn over the Reader to learn the Practise thereof in every Country almost where he shall come.

As for the Refining thereof it may be done in this Manner: Take Filings of Iron two Parts, Antimony one Part, it will melt down like your Lead Oar; take the pure Metal, which will be much more brittle than the Lead was, and melt it with four times as much Lead as it weigheth, then refine it, as before is taught; if you know the Goodness of your Lead before, you may know the Augmentation out of the Iron, which will not quit the Charges out of any Iron made in these Northern Countries, nor yet out of Spanish Iron; but what it may do out of Iron made in the burning Zone I know not; but I conceive it may do well, if any such Iron can be found and made in that Climate.

It is true, that good Gold may be extracted out of any Iron, but not by any common Way, but by a tedious, laborious, and costly Way; and when all is done, there
will

will be no Gain, unless it be in Conceit, which satisfieth no Man, but those who are of my Disposition, who think Experience to be the greatest gain in the World.

CHAP VI.

Wherein is shewed the Operations of Copper.

FIRST, take your Oar, and break it into little pieces, about the Bigness of a Hazel Nut; then lay a Leer of small Char-coals an Inch thick in your Chimney Corner; then lay on your pieces of Oar; then lay on more Char-coals an Inch and an half thick upon the Oar, then kindle and let the Fire burn out of itself;

Then beat it into small Powder, and mingle it with your Sandiver, and Saltpetre, as you did your Lead, without any Filings of Iron, and so melt it down as you did your Lead Oar; only this Difference must be used, by Reason that it is harder of Fusion than the Lead Oar; therefore you must lay the Bricks somewhat wider than you did for the Lead, that it may hold more Coals; besides that you must take the choicest Coals that can be pick'd out, and no very small ones amongst them; also you must have two Pair of Hand-Bellows, and two Men to blow very strongly, and so melt it down.

As

As for the refining it is needless to shew the Manner ; for no Copper in these Northern Countries holdeth any royal Metal, that is considerable ; neither *English* nor *Danizic* Copper ; yet in Regard that in some Mines in *Hungary*, there is generated Gold, Silver, and Copper, all in one Mass of Oar ; and also in Regard that if any Mines of Copper shall be discovered in *Virginia*, or other Southern Countries, there is some good Probability that it may contain royal Metal ; therefore I will shew the Manner how to refine it, and also to part the Gold from the Silver, if it contain both together.

First, melt one Ounce of Copper with four Ounces of such Lead as you know the Goodness of before ; then refine it, and by the Augmentation, you shall know the Worth of the royal Metal contained in the Copper.

If you would try whether the Copper contained any Gold in it, put the Assay, viz. the little Bead or Pearl of Silver into good Aqua-fortis well purify'd before, and if all dissolve then the Copper held no Gold ; but if it leave a black Powder undissolved, that is Gold ; for Lead holdeth no Silver that hath any Gold in it at all ; therefore it is evident that the Gold came out of the Copper.

But if it happen, as often as it doth in the refining of base Metals, especially Tin, Iron, and Copper, that the little Bead, or Pearl remaining in the middle of the Test, is not bright and shining, like the Eye of a Bird, or Fish, but rough, black, and full
of

of Scurf ; then if it be but a little in Quantity, and that the Test be not crack'd, nor full of Clifts, then put to it some more of the same Lead, whereof you know the Goodness, and drive it off again as you did at the first ; and re-iterate this Work till the Assay be pure and clean like a little Pearl, or Bead, as it ought to be.

But if it happen that the Test is very foul, as often it cometh to pass in the Refining of strange Minerals, as *Marcasites*, and especially those which the Mineralists call by the Name of *Devil's Dirt* ; then there is no Way but to let all cool ; and then to dig it out, and with more Lead to melt it again in a Pot, and then to let it cool, and then to break the Pot, and to beat off the Cinder with an Hammer, till you come to the malleable Metal, and you may be assured that no Royal Metal will stay in the Cinder, but sink down into the Lead, through an Attractive Virtue betwixt them.

C H A P. VII.

Wherein is shewed the Operations of Silver.

AS for the melting thereof, when it is found in the Mine of Lead, the Operation is taught in the Chapter of Lead; but if it be found by itself, or mix'd with Gold without Lead, as many times it cometh to pass, then it is to be beaten to Powder, and mix'd with Sandiver, and Saltpetre, without any Filings of Iron, and so melted down like the Lead Oar; only the Fire must be somewhat stronger.

Then it is to be melted with four times as much Lead, whereof you know the Goodness; and so to be refined, as before is declared.

But whereas sometimes this Oar is so strongly mix'd with Sparre, and stony Substances, that it cannot be separated therefrom, by any common Manner of Work used by the Refiners, then this Course is to be taken with it: First, beat it into small Powder, then wash away with Water the greatest part of the Terrestreity and Filth; then dry the Powder, and use it in this Manner:

First, melt four Ounces of Lead, and when it is melted, put to it four Ounces of Quick-

Quicksilver, made hot in another Melting-pot: but let the Lead be almost cold before you put it to the Quick-silver; but yet it must be done whilst that the Lead is liquid.

This done, cast it into an Iron Morter, set warm before upon Embers, and it will be like Pap; then presently with a Pestel, labour in one Ounce of your Powder, or two at the most, till it be incorporated; or so much thereof as will incorporate; for the strong and earthy Substance will not incorporate with the Lead and Quicksilver by any Artifice whatsoever: but the Silver, if any there be, will forsake the earthy and stony Substance, and join itself with the Lead and Quicksilver by an attractive Virtue. This done, put it altogether into a Melting-pot, with a little Sandiver and Saltpetre, and melt it down as you did the Lead Oar; only this must be observed, that the Fire must be more mild at the first a great deal, till the Quicksilver be evaporated, and more strong at the last, that all may flow well together. Then take out the Pot, and let it cool; then break it, and with a Hammer beat off all the Cinder and Scurf, till nothing be left but malleable Metal.

Then refine it according to the common Manner before declared, and cast up with your Pen the Augmentation that is more than the Lead yieldeth of itself: And if there be no Augmentation, then that Mineral Stone contained neither Gold nor Silver; for this is the most exquisite Way in the World to reduce Gold or Silver, which

which is hard to be reduced to a metallical Body, through being strongly mixed with either corrosive Substances, or any other Filth which hindereth it's Reduction: Therefore if this Way fail, you may set your Heart at rest for the seeking out of any other Devices whatsoever, though the glistening Sparks contained in the said Minerals do never so strongly invite you; and you may conclude with the old Saying, that all is not Gold that glisters.

But if it prosper, and yields any Augmentation that is considerable; then if you desire to know whether there was any Gold mix'd with the Silver, as oftentimes there is, where Silver is found without Lead, then put the little Bead, or Pearl of Silver, which remained on the Test into *Aqua fortis*, and if all dissolve, then there is no Gold in that Mineral; but if a black Powder remain, then that is Gold, and the Quantity may be found by farther Trial.

K

CHAP.

C H A P. VIII.

Wherein is shewed the Operations of Gold, and real Experiments whereby any Man may presently try whether any Pieces of Gold be true or counterfeit, without defacing or altering the Form thereof.

AS for the melting of it ; if it be found mix'd with Silver Oar, as oftentimes it cometh to pass, then it is to be melted, refined, and parted from the Silver, with *Aqua-fortis*, as is before declared ; and if there be not five times as much Silver as there is Gold in the Composition, then you must put to so much, or else the *Aqua-fortis* will not dissolve it.

But if it be found in Grains or Powder, as oftentimes it is, then you must put to it *Borax* instead of Sandiver and Salt-Petre, and so melt it down as you did the other Oars before mentioned.

Now as this Metal is the most rich of all the rest, and most thirsted after, I will enlarge my Discourse for the gaining of Means to find it out ; also I will shew the Reason why this royal Metal is many Times found pure of it self, with little or no Mixture of other base Metal with it.

And

And first, whereas it is often found in the Sand in Rivers, let no Man think that it could be generated there, but that the swift Motion of the Water from the high Mountains, brought it thither, with Earth and altogether, till such Time as the Motion of the Water grew more slow; and so according to it's Property, being not able to carry forward still both the Substances, did still carry the Earth with it, and let the heavier Body sink.

Therefore I would have those that have Occasion to deal in the hot Countries where Gold is usually generated, to make trial in all such Rivers which run from great Mountains with a swift Course in such Places, where the Motion of the Water beginneth to grow slow.

And for this Purpose he may have a little Bucket of Iron that will not lie in the Bottom, but on one side, which Side must have a Shoe like a Shovel; so that being drawn a little forward, as it lies in the Bottom it will fill itself with Sand: Which you may try by grinding it with Quicksilver whether it contain any Gold: For if there be any Gold in the Sand, it will mix with the Quicksilver willingly: Then you may wash away all the Sand, and strain the Quicksilver through a skin of Leather, and if any Gold be gathered into it, there will remain a Ball in the leather: Then you may evaporate the Quicksilver from the Ball in a melting Pot, and so melt down the Gold with a little Borax.

Also sometimes Gold is found in Rivers, in powder and Grains, far distant from any

Mountains, of swift Motion of Water: This plainly demonstrates that the Earth thereabout contains Gold, a Thing usually in hot Countries, and that the Water in that Place had a convenient Motion to wear away the Earth, and to leave the Gold behind; and this is manifestly seen by Experience where they wash whole Mountains of Earth with Water, thereby to separate the Gold from it.

Now as I have formerly affirmed that all Metals in general are generated of the clammy and glutenous Part of the subterranean Vapours arising from bituminous and sulphurous Substances, kindled in the Bowels of the Earth, it behoveth me to shew how Gold, such a fixed Substance, can be found pure of itself, and not mixed with other base Metals.

And the Reason of this can be no other, but because that all other Metals whatsoever will putrify in the Earth in Length of Time, and turn to Earth again; but Gold will never putrify by Reason of it's excellent Composition, being made of a balsamic Sulphur, or Fatness, which is incombustible, and differeth from the Sulphur or Fatness contained in other Metals, even as natural Balsom differeth from all other Oils, and fat Substances: So that though it be an Oil in shew, yet it will sink in Water, whereas all other Oils will swim upon the Top of the Water.

And this is the Cause why Gold sinketh so eagerly in Water, which may be proved by weighing a twenty Shilling Piece of Gold against a Brass Weight, and then letting the

Scale

Scales sink in a Basen of Water three or four Inches deep, the Gold will there over-weigh the Brass about nine or ten Grains by Reason that the Brass is more inclined to swimming through the combustible Fatness or Sulphur in it's Composition; and as for the twenty Shilling Piece, so for any other Piece of Gold whatsoever according to it's several Brass Weight you may in like Manner try *whether it be true or counterfeit.*

Now whereas the Substance of Gold is not subject to putrify in the Earth by any Length of Time it is probable enough that other Metals might be generated with it at the first, and afterward putrified and consumed from it in Length of Time, leaving the Gold pure,

For I have drawn Iron, or a Substance much like to Filings, or Atoms of Iron out of grain Gold that was brought from *Guinea* with a Load-stone, which seem'd to be Iron not fully putrified and turned into Earth.

And the Reason why the hotter the Country is, the richer the Minerals are, can be no other but the same, that roasted Meats are sweeter than boiled Meats, or raw Meats: The Reason whereof is plain, for that the rawish and unsavory Part is exhaled by the Heat of the Fire, leaving the sweeter Part behind.

Even so in hot Countries, all that Part of the subterranean Vapours, which here is condensed into Lead, and other base Metals, can there have no leave to congeal, by Reason of the Heat: But is all or most Part thereof exhaled out of the Mines, leaving behind

the royal Metals, whose Property is to coagulate with Heat: Whereas the Property of the base Metals is to evaporate with Heat and to congeal.

The contrary Opinion to this; namely, that the Substance of the best Metals are convertible into royal Metals by Heat and Digestion, hath filled the World with false Books and Receipts in Alchymy, and hath caused many Men to spend much Money, Labour, Study, and Charges to no purpose.

For I know, by good and long Experience, and by many accurate Trials, that Quicksilver, the most friendly Mineral, the royal Metals, can by no Means, or Artifice whatsoever, be fixed or coagulated into either of the royal Metals. Also I have found since, that no Author of Credit or Reputation teacheth any such Thing; but, on the contrary, condemns all such Operations to be false.

For the Substance of the royal Metal is quite contrary to that of base Metals, even as the fixed Salt of any Vegetable, is different from the volatile or fugitive Salt of the same. Yet I don't deny but by Art there may be drawn some small fixed Part out of the base Metals, which may be converted into royal Metal, though with much Labour, Charge, and Loss.

For as a Tree, or other Vegetable, being burned, doth yield a fixed Salt, or Ashes, so the base Metals do contain some small Quantity of Matter, of the same Nature that the royal Metals are compounded of.

And, for the further Satisfaction to the Reader, I will shew, in the next Chapter, a true Receipt how to make true Gold, abiding
all

all Trials, and having all Properties, active and passive, which true natural Gold hath; but, instead of Gain, Loss will be ready to follow the Work.

C H A P. IX.

Wherein is shewed how true and perfect Gold may be made by Art, with Loss to the Workman.

Thus I wrought.

I Took 8 Ounces of Regulus of Iron and Copper, made as beneath is declared, and 16 Ounces of common Sublimate, bought at the Apothecaries, and made these Ingredients into fine Powder; first severally, and then I ground them well together upon a Marble Stone, and so put them into a Retort of Glass, and drew from them first an Oyl, then a Substance like Butter, and lastly a yellow Sublimate, tinged with the Tincture of Iron and Copper, which yellow Sublimate I rectified three or four Times, till it was very pure; then I mixed it with equal Parts of an Amalgam of Silver and Quicksilver, made as beneath is taught, and put it into another Retort of Glass, and forced away all but the Silver, which remained like yellow Horn; this yellow Silver I amalgamed again with new Quicksilver, and set it in gentle Heat about a Week, then in a very

strong Heat for six Hours; so that the Quick-silver rose up, and fell down again upon the Silver, till such Time as it had carried up all the Silver from the Bottom of the Glass, into Branches like Trees; then I melted down the Silver, and fined it, and parted it with *Aqua-fortis*, and had diverse Grains of pure and good Gold, abiding all Trials; but the Quantity would not pay for half the Charges and Labour.

I made the *Regulus* thus: I took 4 Ounces of Iron in stub Nails, and made them red hot in a Crucible, and then I put to it 8 Ounces of crude Antimony, and melted it down, and when it was well and thin melted, I let it cool in the Pot, and so knock'd off the *Regulus* from the Lop or Cinder, which lay upon the Top of it; then I did the like with 4 Ounces of Copper, in thin Plates; and then I mixed equal Parts of these two, and melted them three or four times, every time casting into the Pot half an Ounce of Saltpetre, as it was in melting, to purify it, till it was pure and bright almost like Silver, but yet brittle, so that I could beat it in a Mortar to fine Powder.

The yellow Silver that was like yellow Horn did amalgam, with much Difficulty and Grinding, with Salt and Vinegar, and some of it was lost, do what I could; but the first Silver was water Silver, which I bought at the Refiners, out of which they had taken all the Gold before; this did amalgam very easily; then I strained it to a Ball through a Leather Skin, and so mixed it with the yellow
Sublimate

ublimete that was tinged yellow with the Tincture of Iron and Copper.

The Proportion of the Quicksilver to the Silver was five or six Parts to one.

If any one doubt the Truth of Alchymy, he may be satisfied by this Trial; but, instead of Gain, he shall pay for his Learning, by going away with Loss.

I do not deny but there are Works of less Loss and Charge, yet none of them lucrous, by reason of the Change of Times.

For if any one will uphold me as good a Lease, or Purchase of Land, as I can prove by credible Records, hath been had in former Times for an Ounce of Gold, I will undertake to make an Ounce of Gold by Art to pay for it, and yet have a good Bargain.

But the Difference of Times hath confounded this Art, as may appear more plainly beneath.

First, In ancient Times a Man's Work was not worth above a Penny a Day, which now is worth two Shillings and Sixpence a Day, as may appear by ancient Records for Buildings, and the like; so that there is thirty to one Loss in the Workmanship.

Secondly, Then Coals, Vessels, and other Things necessary for these Affairs, did cost little in respect of the Charge now.

Thirdly, When the Gold was made, it would then have bought thirty or forty times as much, either Lands, Leases, Victuals, or Workmanship, as now.

So I conclude, that then the Owners of this Art might gain thirty or forty for one, and yet now they shall loose extreamly.

C H A P. X.

Wherein is shewed the Operations of inferior Minerals.

AS for these base Minerals, *viz.* Cinabar natural, Antimony, Sulphur, Auripigment, Arsenick, Talcum, *Muscovy* Glasse, Emery, and many other Things of like Nature, because they are of small Value, and not worth the seeking for on purpose, I will omit further to discourse of them; if any Man shall find them, or any of them, by accident, let him use his own Pleasure, Skill, and Industry in the proceeding of them.

Nevertheless, because Cinabar natural may contain much Quicksilver, which is very useful for many Things; and may prove as beneficial as a good Mine of Metal, especially if it be found in great Plenty. I will therefore shew the refining Separation, and purifying of the same in small Proportion; so that if it should be found a profitable Work, then the Finder thereof may proceed to a greater Work. The first Thing then to be done, is to consider of the Weight thereof; if it be very ponderous, reddish in Colour, and full of clear Streaks, shining almost like the Streaks of Antimony, then it is a good Sign of a rich Mine.

The first Trial to be made thereof, is to weigh a Piece thereof, and so put it into a gentle

gentle Fire, for an Hour or two, that it may be only red hot; then let it cool, and weigh it again; and so, by the Lightness thereof, being compared with the former Weight, you may judge somewhat of the Richness thereof.

Then take a Pound thereof, and beat it into fine Powder, and mingle it well with as much unsleat Lime, put it into a Retort of Glass, luted with Potters-Clay, and some Horse-Dung, well beaten and tempered together; then set it in a little Furnace in your Chimney Corner, and force it with Fire twelve Hours; let it be kept red hot the last four Hours; and let the Nose of the Glass enter into another Glass, filled almost full of Water, in such manner, that the Vapours of the Cinabar must needs enter into the Water, for the better Condensation thereof into Quicksilver.

This done, separate your Quicksilver in the Bottom of the Water, and dry it and weigh it; if you find the Quantity considerable, then you may proceed in this manner.

First, Make a Hole in the Earth, with very good tempered Clay that will hold Water, and let it be narrow in the Bottom, and wider and wider above to the Top, to the Breadth of two, three, or four Yards; then fill the Pit with Water, and lay over it Bars of Iron, of sufficient Strength and Thickness to bear the Burthen that must lie upon it; and then let them lie so near together, that the Stones and Wood cannot fall through; then lay thereupon a Leer of dry Wood, and a Leer of your red Stone, not broken small; and so do again, till it be a Yard thick, or more; then give

Fire

Fire to it on the Wind-side, and go away out of the Danger of the Fumes, till you see afar off that the Fire is finished and burned quite out.

Then repair to your Work, and let out the Water through a Pipe of Lead, which should be formerly laid almost at the Bottom of the Pit, into another Pit near to it, made so deep that it may receive the Water; and in the Bottom you shall find great Store of Quicksilver, if the Mine was good.

The Water may be pumped up again, to serve the next Day for the same Use; and you need but to take up a few of the Bars of Iron every Day, to go down into the Pit, to take out your Quicksilver, and so lay them down again.

C H A P. XI.

Wherein is shewed the Way to find out Pit-Coal; also the natural Cause of the Generation of them, by a plain Demonstration.

THOUGH this Mineral be of small Value, yet if a good Mine thereof shall be discovered in some particular Places of this Land, the Benefit thereof will far exceed the Profit of any Metal Mine usually found in these Northern Countries, by reason that Wood is so greatly decayed of late Years; that were it not

not for this Help, many People would be in danger to be starved.

The first Thing, therefore, which I would have to be diligently observed is, that this Mineral is usually found in Ground that is prone to bear Wood and Thorns; and not in the very fertile Grounds, nor yet in the extream barren Grounds, but of an indifferent Fertility, and in Grounds that are usually slower in their Growth in the Spring Time, than the fertile champion Countries by a Week or a Fortnight.

Also the said Grounds are prone to bring forth large Cattle, and well horned; but not to feed the said Cattle without a long time, nor yet will they ever be very fat upon the same Ground. Also the Springs issuing out of the said Grounds, are apt to colour the Earth ruddy at their Orifice, like unto the Rust of Iron.

Also the said Spring Water being boiled, as before is taught, doth usually yield a black Residue.

Also if you bury a new Bowl of pure white Wood in the said Grounds, from *March* till *Midsummer*, with the Mouth downward, it will be coloured blackish with the subterranean Vapours.

I had a Receipt given me, for this Purpose, by one that, for his great Experience and excellent Skill in natural Causes, seemed to be one of Nature's Darlings; which, because I have not tried, for want of Opportunity, I will commend it as a very probable Sign, and give such Cautions, that any Man may be
sure

sure of it, before he try his Fortunes by digging or boaring, or any chargeable Way.

And this was his Direction: *About the Middle of May, when the subterranean Vapours are strong, which may be discerned by the Fern, which about that time will suddenly grow out of the Earth in a Night or two, almost an Handful in Length, then take a pure white Piece of Tiffany, and wet it in the Dew of the Grass, which is all of that Spring's Growth, and not spoiled with Cattle, nor other Thing, than wring out the Dew from it, and do so five or six Times, and if there be Coals, the Tiffany will be a little blacked, and made foul with the sooty Vapours arising through the Coals, and condensed amongst the Dew.*

Now, to be sure not to be deceived, do thus: First try where there are Coals, and if you find the Signs above said, yet trust not to the Experiment, till you have tried where there is no Coals in some other Place, wherein it behoveth you to try in diverse Places, till you find a Place where the Tiffany is not soiled at all; then you may be sure that the Experiment is true and infallible.

I admonish him that shall try with the Tiffany upon the Dew, to let his Hands be washed before with Soap and hot Water, and wiped with a pure white Cloth, till they will not foul the Cloath at all; else if they spend their Money in digging, and find nothing, they may thank their foul Fingers for that Misfortune.

As for the natural Cause of the Generation of Coals, this Demonstration following doth make it manifest.

Take

Take a Piece of the black fat Earth, which is usually digged up in the West Country, where there are such a Multitude of Fir-trees covered therewith, and which the People use to cut in the Form of Bricks, and to dry them, and so to burn them instead of Coals; use this Substance as you did the other Earth, in the Beginning of the Book, to find out the natural Cause of Rocks, Stones, and Metals; and let it receive the Vapours of the combustible Substances, and you shall find this fat Earth hardened into a plain Coal, even as you found the other lean Earth hardned into a Stone.

Whereby it appeareth, that Nature doth the same thing in the Generation of Coals under the Ground, by the indurating of a fat Earth with the subterranean Vapours, which are apt to work a various Effect, according to the Substance which they meet withal.

Now, whereas some of inquisitive Dispositions will desire to know the natural Cause of that fat Earth, generated in such subterranean Caverns, let them be pleased to consider that such Places, in former Times, have been the Superficies of the Earth, and afterward have been covered by the Sea with other Earth; which may be demonstrated by two Ways. *First*, It is evident that the Mines of Coals do lie in some Places higher, and in other Places lower, lively resembling the Superficies of the Earth, which is never directly equal, but every where various.

Secondly, Every one may see in the West Country, where such a Multitude of Fir-trees do lie covered so deep in the Earth, that the Superficies

Superficies of the Earth is deeper now than it was in former Ages, when those Trees were brought thither by the Sea; for it is evident that they never grew there; *first*, for that there groweth no Fir-trees in that Country; *secondly*, that they lie cross, and in such uncooth Manner, that no human Strength could ever imitate nor parallel, by any Dvice whatsoever.

Also they may see the Power of the Sea, to alter the Superficies of the Earth, by the Multitude of Earth there laid so many Yards deep upon the Top of the Trees.

Also they may see that the Sea doth make the Difference of the Nature of Earths by it's various Motion, as well as the Unevenness thereof by Hills and Vallies; for there they may see, that some Earth will burn, and some will not burn, being both Sorts brought thither by the Sea, as appeareth evidently by the former Discourses.

Also the Sea never resting, but perpetually winning Land in one Place, and losing in another, doth shew what may be done in Length of Time, by a continual Operation, not subject unto Ceasing, or Intermiſſion.

C H A P. XII.

Wherein is shewed a perfect Way to try what Colour any Berry, Leaf, Flower, Stalk, Root, Fruit, Seed, Bark, or Wood will give; also a perfect Way to make Colours fixed, which will not abide the ordinary Way.

HERE I must confess a manifest Digression from my Subject; yet in regard of the great Benefit which this Experiment may bring to the Country, out of the new Plantations, and other Places, where it is very probable that many of these Things be hidden and unknown, I will crave Pardon, for that my Intent was chiefly to prevent the Loss of those Things, which may do much Good, were it not through Ignorance, or Negligence.

First then, take half a Pint of Water, and half a Pint of Float, made as beneath, Twopenny Weight of Allom, 12 Grains of Tartar finely beaten, put all into a Tin Vessel, which is better than Earth, Lead, or Copper; set it on a Trivet, to dissolve the Allom, upon a gentle Fire; as soon as it beginneth to boil, take a Piece of white Wollen Cloath, well scoured with Soap, Fullers-Earth, or Lee, or altogether, to take out the Grease of it, being well washed out with fair Water, and then dried

dried in the Air or Sun, not by the Fire; the Cloth must weigh but half an Ounce; then tye a Thread to the End of the Cloth, and when the Liquor beginneth to boil, then put in the Cloth, and let it boil an Hour; then take out the Cloth, let it cool, wash it in two or three Waters; then take any Berry, Leaf, Flower, Stalk, Root, Fruit, Seed, Bark, or Wood, and bruise them well; put them in fair Water, and boil them with a gentle Fire, to extract the Tincture; then put in the Cloth formerly prepared, which will shew what Colour they will give.

To make the Float.

Boil an Hoghead of Water; then cast in a Bushel of Wheat Bran; then draw the Fire; then let it stand three or four Days, till it grow sowerish.

But for small Trials a little will serve, observing Proportion between the Water and the Bran.

A Proportion must be observed in the allowing of all Stuffs before they receive their Colours. *First*, The Proportion of Allom to the Water; which is one of Allom to sixteen of Water, and Float. *Secondly*, The Proportion of the Tartar to the Allom; which is one of Tartar to four of Allom. *Thirdly*, The Proportion of Allom to the Cloath; which is one of Allom to five of the Cloath.

Note, That all Silks must be allomed cold, or else they will lose their Lustre.

The

The Way to find what Tincture is hidden in any Vegetable, or in any Part thereof.

Take the Vegetable, being cut green, and stamp and grind the same, as if it were to make Juice thereof; then press out the superfluous Moisture; the Remainder make up in Balls, and lay them up together, that they may gather a little Heat; but let them not heat too much, for then they will turn to Dung. These being sufficiently fermented, must be dried, and afterwards used as Oad is used.

Another Way, as Indico is made.

Make a Pit with Timber and Boards, about a Foot deep, and as wide and as long as you please, being well clayed in the Bottom and Sides; then fill this Pit with any Vegetable cut green; then put as much Water to it as will cover the Herbs; let it stand exposed to the Sun two or three Days; then with a Plug at the Bottom draw out all the Water, and cast it away; then fill the Pit again with fresh Water; and when it hath stood the like Time, draw it away as the former. This do so often, till you find that the Herb will be easily brought into a Mucilage; then it must be trod, and beaten with wooden Instruments like Rammers, till it will all come to a Mucilage; then it must be taken and wrung through Hair Sieves, like *Cassia Fistula* extracted, to keep the great Stalks and Fibres from passing through; afterwards the Mucilage or Pap that

that passeth through must be dried in the Sun, and so formed into Cakes like to Indico.

Another Way.

Take the Vegetable cut green, and stamp and grind it; then take an Hoghead and fill it, with half Water and half bruised Herbs; set it out of the Sun, with the Bung-hole open two or three Inches, till it ferment and work like Wine or Beer; after it hath done working the Herbs will sink, which at the first did swim, and the Liquor will grow a little sowerish; then let it be set abroad in the Sun, and brought into Vinegar, as Wine and Beer is brought into Vinegar; and then that Colour can never be stained with other Vinegar, or Urine, because it is sufficiently impregnated, and it's Appetite satisfied with it's own proper Vinegar. When it's Substance is thus turned into Vinegar, the clear Vinegar must be drawn from it; the Remainder must be used as the former Indico, and some Water to that, to be sure to fetch out all it's tartarous Mucilage, must be put to the Vinegar, and dried away in the Sun, and so they come like Indico: *In tincturam tartarizatum fixam de occulto in manifestum.*

And whereas Barks, Woods, and Roots are of a dry Composition, and will not ferment of themselves with Water, like green Herbs, or Vegetables; therefore they must be well ground, or thin shaven, and there must be added, instead of Water, Juice of Grapes, Pears, Apples, or Wort made of Malt, or other Grain, to which the Wood, Bark, or
Roots

Roots must be put. Let them ferment together, and afterwards be turned into Vinegar; then the clear Vinegar must be extracted; the Residue of the Tincture must be extracted with fresh Water, and both of them must be breathed away in the Sun, as before, and so brought in it's perfect Tincture.

By what hath been declared in this Chapter, it may appear to every one having an inquisitive Disposition, what is the true natural Cause why some Colours are fixed, and will not stain with Vinegar, Urine, nor yet fade with the Air; which hath in it a certain Acetosity, or sharp airy Salt of the Nature of Vinegar, which those Tinctures draw to them, which have not their Appetites fully satisfied before with such spiritual or airy Salts. And this is further manifest; for that all such Tinctures which are most firm and fixed, and are not subject to Staining or Fading, being tasted upon the Tongue, may be felt somewhat sharptish or sowerish.

And the Cause of this appetitive and attractive Virtue in Colours, is no other but the very same which is betwixt the Load-stone and Iron; for take the Load-stone and burn it till all it's blue Vapour be exhaled, and it will draw no more Iron; thereby shewing plainly, that it was that airy Salt, tinged with the veneral or vegetable Greenness, which the Iron thirsted after, to satisfy it's thirsty dry Nature and Constitution, which it got by it's Calcination and Fusion.

And the like Attraction may be discerned by the intellectual Eyes, in any thing that is strongly burnt; so that all Spirits are exhaled.

As

As Lime will draw the airy Substance to it, and thereby quench itself ; also Tartar burned, and laid in the Air, will draw the sharper Part of the Air to it, and thereby dissolve itself ; and, in fine, all corporeal Substances, the more they have lost their spiritual Parts by natural or artificial Operation, the stronger is their attractive Virtue.

Now, instead of filling the Reader's Head with Proclamations, I will conclude my Book with giving Ease to his Memory, by prescribing what Necessaries he is to provide for the accomplishing of his several Designs, in his Voyages, or Plantations, whither his Occasion shall draw him.

And first for him that will only try his Fortunes in the Searching for Minerals.

He will need nothing but two or three Pipkins, two or three Urinals, an Iron Pick-axe, well steeled, a Spade and Crow of Iron, if he will be at the Charge thereof, but there is no great Necessity ; also if he be not acquainted with the several Oars of Metals, it will be convenient that he take with him a little Piece of every Sort of Oar, or so many several Kinds as he can get.

And for him that would proceed further, to try the Value of them himself, he must provide these Things following.

A Grate of Iron of a Foot broad, some Bricks, two Pair of good Hand-Bellows, a Pair of Tongs, some Lead, Salt-petre, Sandiver,

diver, Borax, Flanders Melting-Pots, a Ring of Iron for the Test, an Hatchet, or Hand-Saw to cut Wood, some good *Aquafortis*, Weights and Scales; and if any Man be not active handed enough, he may have a Man for a Trifle, to shew him the manual Practice, in a Day before he go his Voyage.

And for him that will search for dying Stuffs, he may see in the last Chapter what Things he shall stand in need of; also the other Chapters may be perused, whereby every one may be the better accommodated for their several Enterprizes.

F I N I S.



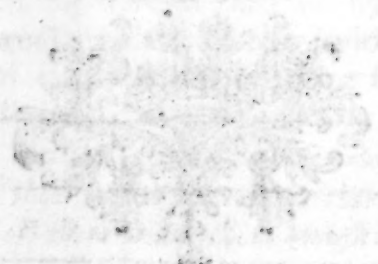
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ANALYSIS OF THE MINES

IN THE STATE OF MINNESOTA

BY J. H. HARRIS, M. D.

CHICAGO: PUBLISHED BY THE AUTHOR, 1880.

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TO ALL
MINERS

AND

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and Prosperity in *LEAD-MINES*.

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by reason few can read them : Therefore, that
every one that can but read might know the
Customs of the Mines, was the Cause I pub-
lished this Book, which will much profit, and
be a ready Help to all that is concerned in
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not only the Liberties, Laws and Customs of the
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ought to know ; but you have also such o'ber
Things, as are, or may be necessary to be
known

DEDICATION.

known to such Persons as are, or may be concerned in Trials upon Juries, or Twenty-four Men; Bonum quo communis, eo melius.

I shall not stand to make Apology for the Book, well knowing Momo enim Judice ter-
tare Frustra; and doubtless this may fall into the Hands of such Criticks, who Zoilus and Momus like, will be ready to speak ill of what is anothers, but ever fancying and affecting their own; which Sort of self-conceited Opinionists I do not think, neither desire to please; but if such rash and hasty Censurers might be premonish'd, 'tis requisite they sometimes admit their Judgments the Possibility of erring. To conclude, 'tis thee, honest Minner, for whom I publish'd this.

Novemb. 12.
1680.

From my Lodging in
Warwick-lane, near
the College of Physi-
cians, London.

THOMAS HOUGHTON.

Rara

Rara Avis in Terris :
OR THE
Compleat Miner.

At the Great Court Barmoot for the
Lead Mines, held at *Wirksworth*,
for the Soak and Wapentake of
Wirksworth in the County of *Der-*
by, the 10th of *October*, in the
Year of our Lord 1665.

The Inquisition of the great late Inquest,
taken upon the Oaths of,

Ro. Haywood.	Ro. Tipping.
Ro. Sage.	Mat. Latham.
Rich. Buxton.	Hen. Coats.
Antho. Cotteril.	John Briddon.
Edw. Weatcroft.	Edw. Bradshal.
John Swallow.	Thomas Daken.
Antho. Gell.	Pet. Rawling.
John Creswel.	Fran. Worthby.
John Topliss.	Edw. Rooper.
George Wittacre.	John Twigg.
Anthony Lowe.	Ralph Hage.
James Holehouse.	John Roose.

ARTICLE I.

WE say upon our Oaths, That by the antient Custom of the *Mines* within the Soak and Wapentake of *Wirksworth*: The *Miners* and *Merchants* at first chose themselves an Officer called a *Bar-master*, to be an indifferent Person betwixt the Lord of the Field, or Farmer, and the *Miners*, and betwixt the Miners and Merchants; which Bar-master, upon finding any new Rake or Vein; did (upon notice given by the Miner) deliver to the first Finder two Meers of Ground in the same Vein; each Meer in a Rape or Pipe-work containing 29 Yards in length, and in a Flat-work 14 Yards square; the which two Meers of Ground the Miner is to have, one for his diligence in finding the Vein, and the other for mineral Right; paying the Bar-master or his Deputy one Dish of his first Oar therein gotten; and then the Bar-master or his Deputy, is to deliver to the Lord of the Field or Farmer, one Meer of Ground in a new Vein, at either end of the aforesaid two Meers half a Meer of Ground; and then every one in such Rake or Vein, one Meer, or more, according to their taking.

ARTICLE

ARTICLE II.

We say if any Miner, or any other Person set on an old Work, then the Bar-master or his Deputy is but to deliver him one Meer of Ground, on either side his Shaft half a Meer of Ground ; for which of mineral Right he is to pay one Dish of his first Oar therein gotten ; and the Lord of the Field, or Farmer, is to have no half Meer in an old Work ; but every one is to be served according to his taking.

ARTICLE II.

We say that no one ought to set on an old Work, or ancient Possession, without the Bar-master or his Deputy, and one or more of the *Grand Jury*, or Twenty-four, of the Mine.

ARTICLE IV.

We say, according to the Custom of the Mines within the Wapentake of *Wirksworth*, That Grooves, Shafts or Meers of Ground, kept in lawful Possession, are an Estate of Inheritance, and descend to the Heirs and Assigns of the Owners ; and Wives to have Dowry in them.

ARTICLE V.

We say, If any Man (to the knowledge of the Bar-master or his Deputy) be lawfully possess'd of a Meer or Meers of Ground, and does not willingly desert the same, but his *Stows* are gone by some sudden accident, or

indirect means, it shall not be lawful for any other Person to take or possess such Meer or Meers of Ground, till the Bar-master or his Deputy set him thereon; and the Bar-master or his Deputy, before he set any Man on such Meer or Meers of Ground, shall first take with him one or more of the Grand-jury, or Twenty-four of the Mine; and go to the place where the Possession, or Possessions, or *Stows* stood, for such Meer or Meers of Ground, and then make open Publication in the mineral time of the Day, That the Party or Parties whose *Stows* stood for such Meer or Meers of Ground, are gone, or taken away as aforesaid, that he or they shall (within four Days after such Publication) come, and make good his or their Possessions for such Meer or Meers of Ground; but if the Party fail to make good his or their Possession within four Days after, then the Bar-master or his Deputy, and the Grand-jury-men, that was at such Publication, may set on any other Man on such Meers of Ground, to work according to custom.

ARTICLE VI.

We say that neither the Bar-master, nor his Deputy, ought to lay forth or measure any Man's Ground, till Oar be gotten in the same Ground to free it withal; and when the Ground is freed, it ought to be measured and laid forth, and *Meer Stakes set the same Day.*

ARTICLE VII.

We say, that every one ought to keep his Ground in good and lawful Possession, with-
Stows

Stows and Timber in Mens sight ; and that Crosses and Holes, without Stows and Timber, can keep Possession but three Days.

ARTICLE VIII.

We say, that all Men ought to work their Ground truly, and chase their *Stool* to their Grounds end ; and so each one from Meer to Meer, according to the custom, unless they be justly hindered by Water, or for want of Wind ; and in such Cases diligence ought to be used, to gain Wind, and to get out the Water.

ARTICLE IX.

We say, that the Bar-master, or his Deputy, ought to walk the Mine once a Week at least, and where he sees a Meer of Ground which to his knowledge is lawfully possessed, to stand unwrought three Weeks together, and might be wrought, not being hindered by Water, or for want of Wind, then he ought, if he can conveniently, to give notice to the Parties, that neglect to work according to custom ; Then he shall nick the *Spindle*, each Week a Nick, for three Weeks together ; and if it be not wrought within that time, nor borrowed of the Bar-master or his Deputy, then within two Days after the last two Day of the said three Weeks, the Bar-master or his Deputy may lawfully set on another Man on such Meer or Meers of Ground, to work according to Custom ; and if the Bar-master neglect to do his Duty herein, he shall forfeit five

Shillings to the Lord of the Field, or Farmer.

ARTICLE X.

We say, that if two several Parties or more set Possessions for one and the same thing, claiming for one and the same Meer of Ground: Thereupon the Party grieved shall complain to the Bar-master or his Deputy, who shall forthwith bring with him four or more of the Grand-jury or Twenty-four to view the Possessions, and inform themselves the best way they can, who hath the most ancient and lawful Possession for that Meer of Ground, and shall settle the same, casting off the other, and cut out the *Spindle* of such *Stows* as they so cast off: And if the Party whose Possessions they so cast off, think he has wrong thereby, and think he has a good Title to such Meer or Meers of Ground, he may put a new *Spindle* into his *Stows*; and any time within fourteen Days after such casting off, set them on again; thereupon giving the Bar-master or his Deputy Four pence, to arrest such Meer or Meers of Ground, and so try his Title: But if he set on his *Stows*, and do not arrest within Fourteen Days after, as aforesaid, he shall incur a fine of Forty Shillings upon his Head for every such Offence; and the Bar-master or his Deputy ought forthwith to burn his *Stows*, in the mineral time of the Day: And then if he sets not on another Pair of *Stows*, and also arrest the next Day after, his Title to such Meer or Meers of Ground shall be deemed unlawful, and to have no Plea for the same in the *Barmoot-Court*.

ARTICLE

ARTICLE XI.

We say, that the Lord of the Field, or Farmer, shall at all times hereafter provide and keep, between Merchant, Buyer and Seller, a just and right *Measure* or *Dish*, according to the ancient Gage, and such a Number of them, as shall at all times of the Year conveniently measure all such *Lead-Oar* as is got in the *Wapentake* of *Wirksworth*; and such *Dishes* ought to be seized every quarter of a Year, by the *Brazen-Dish*, in the presence of Four or more of the Grand-jury or Twenty-four; and for a Pain every time failing herein, to forfeit 3 s. 4 d.

ARTICLE XII.

We say, that by the said *Dish* or *Measure*, the Lord of the Field, or Farmer, is to take his Lot, which is the 13th *Dish* or *Measure*, as it is justly and customarily paid. But we say that smytham and forested Oar hath not (within the Memory of Man) paid, nor ought to pay any Duties, or Part, but *Cope only*.

ARTICLE XIII.

We say, that for the Payment of the said Lot, *Miners* within the *Wapentake* of *Wirksworth*, ought to have Liberty to work the Ground within the *Wapentake*, and to have Timber also in the King's *Wasts* to work their Ground withal, and egress and regress from the Highways to their *Grooves* and *Mines*.

ARTICLE XIV.

We say, that the Bar-master, or his Deputy, ought to lay forth the *Miners* the next way to the Highway, for going and coming to and from their work, and also for carrying to and from their Work, the running Water to wash their Oar withal.

ARTICLE XV.

We say, (by the custom of the Mine) that all Miners and their Servants may wash their Oar, with Fat and Sieve upon their Works, so that they keep their Fats close covered, and empty their Sludge into some convenient Place, within their length or quarter Cord, as the Bar-master or his Deputy, shall appoint, so that the Cattle of the Owners or Occupiers of the Land where such washing is, may have no harm.

ARTICLE XVI.

We say, (by the Custom of the Mine within the *Wapentake* of *Wirksworth*) 'tis lawful for all the Liege-people of this Nation to dig, delve, subvert, mine and turn up all manner of Grounds, Lands, Meadows, Closes, Pastures, Moor or Marshes for Led-ore, within the said *Wapentake*, of whose Inheritance soever it is, Dwelling-houses, High-ways, Orchards, or Gardens excepted; but if any arable Grounds, Lands, or Meadows be digged, delved, subverted, or mined, and not wrought lawfully according to the Custom of the Mine, then it may and shall be lawful for the Inheritors of the Ground so digged, subverted, and mined,
the

the same to fill up, at their Will and Pleasure.

ARTICLE XVII.

We say, that no Person or Persons ought to keep any counterfeit *Disb* or *Measure* in their Houses, Coes, or any other Place, to measure Oar withal, but every one ought to buy and sell by the Bar-master's lawful *Disb*, and no other to be used or had; and every *Buyer* offending herein, shall forfeit for every such Offence Forty Shillings to the Lord of the Field, or *Farmer*; and the *Sellers* thereof shall forfeit their Oar, if it be taken at such time.

ARTICLE XVIII.

We say, that if any poor *Miner*, or any other poor Person, have Oar (under a *Load*) to measure, and the Bar-master or his Deputy have notice thereof, and do not (upon warning and request) come to measure the same, then every such Person may lawfully take two of his Neighbours, and deliver his Oar to whom he will, so that the customary Duties be paid.

ARTICLE XIX.

We say, that the Bar-master or his Deputy, shall see that measure be indifferently made betwixt the Buyer and Seller; and the Buyer not to touch the *Disb*, or to put in his Hand to make measure, on pain to forfeit Ten Shillings.

ARTICLE XX.

We say, that after the Oar is measured, the Merchant, Buyer, or Miner, that carries away the Oar, doth pay to the Lord of the Field,
or

or Farmer, *Cope*, being Six pence of every Load of Oar, nine *Dishes* to the Load ; for the which *Cope*, the Miners or Merchants have Liberty to carry away the Oar, and sell and dispose of it to whom they please, to their best Advantage, without the disturbance of any Man.

ARTICLE XXI.

We say, that if any Person, or Persons, will make any claim or Title to any Grooves, or Meers of Ground, Rake, Vein, or Oar, he ought to arrest the same, according to the custom of the Mine, and the Defendant ought to be bound in a Bond (with sufficient Sureties for him to the Plaintiff) to answer at the next *Barmoot-Court*, to such Actions as shall be brought against him, by the Plaintiff, upon the said Arrestment ; and after to yield so much Oar, or the value thereof to the Plaintiff, if the Defendant be cast, by the Verdict of 12 Men ; as shall be gotten at such Grooves or Meers of Ground, from the time of such Arrest, till such Trial at the *Barmoot-Court*.

ARTICLE XXII.

We say, that after any Arrest made, the Bar-master, or his Deputy, upon request made, ought to appoint a *Court-Barmoot* within ten Days, or as soon as he can conveniently : And if the Plaintiff do not pursue his Suit upon the Arrest, he shall then lose Six Shillings and Eight pence to the Steward ; and a Nonsuit shall pass against him : And we say, that a Nonsuit is to be of the same Effect and Validity with a Verdict ; and every way to signify

nify as much ; and if the Defendant fail to make his Defence, a Verdict shall pass against him for his Default.

ARTICLE XXIII.

We say, whosoever shall be condemned and cast by a Verdict of 12 Men ; or otherwise, if a Jury, be summon'd and upon calling appear, if the Plaintiff will not go on, and follow his Suit, he shall pay Four Shillings for 12 Mens Dinners : And *Pawns* shall be put in on both parts, into the Bar-master, or his Deputy's Hands, at the time of the Arrest, or within three Days following.

ARTICLE XXIV.

We say that the Defendant ought to have six Days time at least, before any Court, to prepare himself for his Defence ; and what Arrests are made within six Days next before the Court, the Defendant may, if he please, refuse to answer, and not suffer any Loss thereby ; and such Arrests made within six Days, to be void, unless both Parties be willing to go on to Tryal.

ARTICLE XXV.

We say, that the Bar-master, or Steward, ought Yearly to keep two great *Barmoot-Courts* on the Mine, one about *Easter*, and the other about *Michaelmas*, within fourteen Days before or after the said times ; and every three Weeks a Court, if need be, yearly. If either Plaintiff or Defendant request a Court, he is to keep one within ten Days after such Request, or forfeit Ten Shillings.

ARTICLE

ARTICLE XXVI.

We say, if any Groove, Shaft, or Meer of Ground be arrested, all the Oar got or measured at such Groove, Shaft, or Meer of Ground, from the Arrest to the Tryal, is liable to the Arrest: And if the Verdict be found for the Plaintiff, then the Defendant shall pay to him so much Oar or the Value thereof, as shall appear by Evidence was gotten, or measured at such Groove, Shaft, or Meer of Ground, from the time of the Arrest, till the Tryal: And when the Bar-master, or his Deputy, makes such Arrest, he ought to take good Security for the Oar that is to be measured there, or carried away to any other Place.

ARTICLE XXVII.

We say, that honest and able Men ought to be summon'd for Jurors, out of every Division within the *Wapentake*; and to be summon'd as near the Court-day as may be; and of every Division some to serve, unless some just cause be shewed to the contrary.

ARTICLE XXVIII.

We say, that able fit Men, if they be not Miners, if they have Parts and be Maintainers of Mines, and known by the Bar-master, or his Deputy, to understand well the Custom of the Mine; they ought to serve for Jurors, especially in difficult and weighty Matters and Causes.

ARTICLE

ARTICLE XXIX.

We say, that one Verdict for Wages due to Workmen, shall fully conclude and determine. And for the Title that ariseth by Contract, as by Gift, Sale, or Exchange, (or the like) and also for right of Possession, for Shafts or Meers of Ground; two of the first Verdicts for one Party, shall fully conclude the Title.

ARTICLE XXX.

We say, that when a Verdict is gone for either Party, if he which hath lost will have another Tryal for the Title, he ought to arrest within Fourteen Days next after the Court, when the Verdict went against him; or else that Verdict shall determine, and fully exclude him from any further Claim; unless that longer time for Workmanship be absolutely necessary to discover the Truth: If so, then the Party grieved may within fourteen Days cause four or more of the Grand-jury, or Twenty-four, to view the Work in question; and what time they think fit for Workmanship to discover the truth; that they may allow, giving such their doings (under their Hands) in writing to the Bar-master or his Deputy of that Division: And if it proves the allowed time be too short, then the grieved Party may again procure Four or more of the Grand-jury, or Twenty-four, to view the Work a second Time; and if they then find that Workmanship hath been duly made, and yet more time is requisite, they may give longer time again, in manner as aforesaid: And then if the Party grieved arrest not within ten
Days

Days after the time is expired, that Verdict that went against him shall fully conclude and determine the Title.

ARTICLE XXXI.

We say, that no Person ought to sue for Mineral Debt, Oar, Grooves, Trespasses in Grooves, or Grounds in Variance, but only in the *Barmoot-Court*; and if any do the contrary, they shall lose their Debt and Oar for which they are in Controversy, [and shall pay the Charges in Law, and lose all their Grooves, or Meers of Ground, and Parts thereof to the Party grieved, till upon just account, he have satisfaction for all his Charges and Expences in and about such Suits] to the Lord of the Field or Farmer: Also all such as sue out of the *Barmoot-Court*, as aforesaid, ought to have no Benefit, nor Plea in *Barmoot-Court*.

ARTICLE XXXII.

We say, no Officer ought, for Trespass or Debt, to execute or serve any Writ, Warrant, or Precept upon a Miner, being at his Work on the Mine, nor when the Miners come or go to the *Barmoot-Court*, but the Bar-master or his Deputy only.

ARTICLE XXXIII.

We say, if two several Parties, or more, be Groove-fellows, or Part-owners to one Groove, or Meer of Ground, and one or more of the Part-owners will not keep Company nor pay his or their proportional Part or Parts of all such Workmanship, and other Charges
and

and Expences as are uecessary and conducing to such Groove or Grooves, Meer or Meers of Ground : Thereupon the Party grieved shall complain to the Bar-master, or his Deputy, who shall take with him two or more of the Grand-jury, or Twenty Four, and speak to the Party or Parties who neglect or refuse to pay Charges, and keep Company as aforesaid, and give him or them warning to come in within ten Days to pay Charges and keep Company with their Part-owners ; and if (after warning given) the Party or Parties refuse to pay Charges, or to come in and keep Company as aforesaid ; then the Bar-master or his Deputy, and the Grand-jury, or Twenty-four, at their meeting next following (unless some just cause be shewed to the contrary) may order the Party or Parties, that have refused and neglected to pay Charges, and keep Company, that he or they shall come and pay Charges, and keep his or their Part-owners : And such order of the Grand-jury, or Twenty-four is to be binding, as though it was at *Barmoot-Court*.

ARTICLE XXXIV.

We say, that when a Meer or Meers of Ground are wrought under Water, and by reason thereof hath stood many Years unwrought, and the Owner or Owners of such Meer or Meers of Ground do not use some effectual means to get forth the Water, to recover the same ; and that the same might be wrought by the means of a *Sough*, or *Engine*, and that for the public good, but is yet neglected : Thereupon any Person or Persons,

sons, who are minded to disburse and lay forth Money, to recover such Works from Water, may, at a great *Barmoot-Court* held at *Wirksworth*, declare such their Intentions, in Writing, to the Grand-jury, or Twenty-four, and they shall take the same into consideration ; and if they know such Works to have stood so long, by reason of Water, and no effectual means used to win the same ; and that the Person or Persons who desire to undertake to win the same by *Soughs*, or otherwise, to be able Men, and like to perfect such a Work : Thereupon the Grand-jury, or Twenty-four shall appoint a Day (a Month after at least) for themselves, and the Party that undertakes, and all the Owners of such Works, to meet at the place where such Works are, and this time of meeting shall be publish'd by the Cryer in the great *Barmoot-Court*, that all Men may take notice thereof. At such meeting the Undertakers shall give the Grand-jury, or Twenty-four, to understand by what means they intend to lay dry all such Works, and to get out the Water, for recovering the same ; and if the Grand-jury, or Twenty-four, thereupon conceive the way and means they propose is like, and effectual to recover such Work from Water, so that the Public may have advantage thereby, the Grand-jury, or Twenty-four, shall acquaint the Owners of such Works with the Intentions of the Undertakers, concerning the recovery of such Works from Water, and the way and means they propose for the doing of it. And any of the Owners of such Works (if they please) may joyn with the
Under-

Undertakers, paying their proportionable Parts of the Charge of such *Soughs* or *Engines* as shall be made to recover the same, according to their Parts, and enjoy the Benefit thereof. And such of the Owners of such Works, as shall not (by themselves, or others by their Authority) appear at such Meeting; or then neglect or refuse to join, and pay their proportionable Part or Parts of Charges of such *Soughs* or *Engines* as shall be made and used for the Recovery of such Works from Water, as aforesaid: Thereupon the Grand-jury, or Twenty-four, and Bar-master, or his Deputy, shall have Power to dispossess such Owner or Owners from their Part or Parts, and to assign and deliver Possession of such Part or Parts to the Undertakers thereof, as aforesaid; withal, ordering, That the Undertakers of such Works shall give to the Owners, that refuse and neglect, as aforesaid, such reasonable Satisfaction as the Grand-jury, or Twenty-four shall then think fit. And if it happen, in the carrying on of the Business for the Recovery of such Water-Works, that any Difference arise betwixt the Undertakers and the Owners of such Works, or any of them, so that the Work is obstructed thereby; then the Grand-jury, or Twenty-four, being called together, shall have Power to regulate all such Difference, whereby the Work may be effectually accomplished for publick Good.

ARTICLE XXXV.

We say, that when any Man is possessed of a Groove or Meer of Ground, and hath found the Vein, and works therein, he ought to suffer

fer his Neighbour, who is the next taker, and shew him the best Light and Direction he can, which Way, and upon what Point the Vein goeth: But in case any Man be so refractory as to deny his Neighbour such a Courtesy, then he may procure three or more of the Grand-jury, or Twenty-four, to be summoned, and the Bar-master, or his Deputy, may put them into his Groove, who hath the Vein in Work, where they may (by using of a Dial, or some other Skill) shew him that is the next *Taker*, which Way, and upon what Point the Vein goes, so that he may know thereby where to sink his Shaft to find the Vein; that the Field may be set forwards for the publick Good; provided always, that such of the Grand-jury, or Twenty-four, as go into the Groove aforesaid, shall not do any other Act or Thing, or make any other Discovery of such Groove, save only to see which Way, and upon what Point the Vein goes.

ARTICLE XXXVI.

We say, that where any Man is lawfully possessed of a Meer of Ground, for any Rake or Vein, and works the same truly according to the Custom of the Mine; if any other Man shall set *Possessions* at, or near his *Fore-field*; pretending for a cross Vein, or some other Thing; and by Workmanship shall be strongly suspected to work in the same Vein, for which there is another in Possession, and truly works the same; thereupon the Party grieved may procure the Grand-jury, or Twenty-four, to be summoned to appear at the Place in Question; they, or so many of them as appear,
being

(being above twelve) shall view the whole Work; and if thereupon they find, by their best Skill, the *Thing* in all Probability to be one and the same; and yet for want of Workmanship cannot then plainly appear, then such of the Grand-jury, or Twenty-four, as appear and view, as aforesaid, shall give such their Opinions under their Hands in Writing; withal, ordering who they conceit works wrongfully, forthwith to give the Party grieved good Security for all the Oar got at the Work in Question, till Time and Workmanship make the Truth appear; but if the Party who is to give Security, refuse to give such Security, then such of the Grand-jury, or Twenty-four, as appear and view, as aforesaid, shall (by their Order under their Hands) appoint the Bar-master, or his Deputy, to seize and sequester all the Oar got at the Work in question, till Workmanship do make the Truth appear, to whom the Vein belongs; and when either Party does conceit that Workmanship enough is made in it to make the Truth appear, then either of them may procure the Grand-jury, or Twenty-four, to be summoned again; and such of them as appear, being above Twelve, shall view the Work in Question; if then, by Workmanship, it may appear to whom the Oar and Vein belongs, they may order it the same Party to whom they conceive it due; and if either Party think he hath wrong thereby, he may arrest, and have his Trial for his Right or Title.

ARTICLE

ARTICLE XXXVII.

We say, that no Person shall come to any Workman that works his Ground truly, upon any Colour or Pretence to claim his Ground, to hinder his Work, or to stop the *Field*; but the first Workman shall only work, and the Claimer arrest, and take the Law, and the Bar-master shall do him Law truly.

ARTICLE XXXVIII.

We say, if any Vein or Rake go cross thro' another Rake or Vein, he that comes to the *Pee* first shall have it, and may work therein, so far as he can reach with a *Pick*, or *Hack*, having a helve three Quarters of a Yard long, so that he stand wholly within his own Cheeks, when he works such a *Pee*.

ARTICLE XXXIX.

We say, that when two Veins go together, parted with a Rither, that it is scarce discernable whether it be two Veins, or but one; in this case, so long as the Rither may be taken down by firing on the one Side, it is to be taken and reputed but for one Vein; but in Case the Rither be so thick that it cannot be taken by firing on the one Side, and the Veins go so asunder, for half a Meer in length, then they are serviceable to the Miner, as two distinct Veins.

ARTICLE XL.

We say, that any Miner, in an open Rake, may kindle and light his Fire, after four of
the

the Clock in the afternoon ; giving his Neighbour lawful Warning thereof.

ARTICLE XLI.

We say, if any Miner, or other Person, do under-beat his Neighbour's Meer, and work out of his own length into another Man's Ground, the Party so grieved may procure two or more of the Grand-jury, or Twenty-four, to view such a Trespass, and order the Party that hath done the Wrong to give the Party grieved full as much Oar as the Value thereof, as they conceive is gotten wrongfully, without allowing any Charge for getting the same ; and the Party offending herein shall forfeit for every such Offence five Shillings and four pence ; which Fine the Bar-master, or his Steward shall have.

ARTICLE XLII.

We say, that if any Miner, or other Person doth work, and keep lawful Possession of any Groove, Shaft, or Meer of Ground, according to the Custom of the Mine ; if any Person or Persons (by Day or Night) cast in, or fill up such Shaft, Groove, or Meer of Ground, however they shall be wrought ; every such Person offending herein shall forfeit for every such Offence ten Pounds, the one half to the Lord of the Field, or Farmer, and the other half to the Bar-master, or Steward ; and shall pay the Party so much as will make good the Work again.

M ARTICLE

ARTICLE XLIII.

We say, that if any Person or Persons shall at any Time go to any Gentleman, or other Person, and give, sell, or exchange any Part or Parts of a Groove, or Meer of Ground in Variance, for Maintenance; every Person so offending shall thereby lose his Groove, or Meer of Ground, or Part thereof in Variance; and the Taker or Buyer shall forfeit ten Pounds to the Lord of the Field, or Farmer.

ARTICLE XLIV.

We say, that if it happen that any Miner be killed, or slain, or damped upon the Mine, within any Groove, neither Escheator, Coroner, or any other Officer ought to meddle therewith, but the Bar-master, or his Deputy.

ARTICLE XLV.

We say, that no Person ought to bring any unlawful Weapon to the Mine; and for every Rime so doing, to forfeit 3 s. 4 d. to the Steward, or Bar-master: And if any make an Assault or Fray on the Mine; every such Person ought to forfeit for every such Offence 40 s. and for every Blood-shed against the Peace, 5 s. the one Half to the Lord of the Field, or Farmer, and the other Half to the Bar-master, or Steward.

ARTICLE XLVI.

We say, that every Man that hath a Wash-trough, ought to have seven feet about the same; and if any Person dig, delve, or shovel in the said Trough within the said Space, he shall

shall forfeit for every such Offence 12 *d.* to the Steward: Also we say, that no Person ought to dig, delve, or shovel near any Man's Bing-place, upon pain to forfeit 12 *d.* for every such Offence.

ARTICLE XLVII.

We say, that no Person or Persons ought to cave upon any Man's Ground except the Owner be present on the Ground, on Pain to forfeit the Oar they get to the Owners of such Ground, if they be taken: And also 6 *d.* to the Lord of the Field, or Farmer, so often as they shall be taken therewith. Also, no Purchaser ought to stop him, or any Miner, from any Wash-trough, at any Time, on pain to forfeit for every such Offence, 12 *d.* to the Lord of the Field, or Farmer: Also no Caver ought to purchase in any Man's Ground, before eight of the Clock in the Morning, nor after four in the Afternoon, on pain to forfeit for every such Offence, 12 *d.* to the Lord of the Field, or Farmer.

ARTICLE XLVIII.

We say, that if any Person or Persons feloniously take away any Oar or other Materials from any Groove, Shaft, or Meer of Ground, Houses, Coes, or smilting Houses, or elsewhere, if it be under the Value of 13 *d.* half-penny; the Bar-master, or his Deputy, shall punish the Offender in the Stocks, or otherwise, as is fit for such Offenders to be punished: But if the Oar or other Materials be above 13 *d.* half-penny, we say it is Felony.

ARTICLE XLIX.

We say, that every Bar-master, or his Deputy, ought to have a Pair of Stocks, at some convenient Place within his Division; the same to be built at the Charges of the Lord of the Field, or Farmer; by the Benefit arising out of the Fines; and such Persons as swear, curse, or commit any other Misdemeanors on the Mine, fit to be punished in the Stocks; the Bar-master, or his Deputy, shall punish such Offenders, at any Time under the Space of twelve Hours, as the Offence shall require.

ARTICLE L.

We say, that no Miner ought to be fined or amerced by the Steward of the *Barmoot-Court* for his not appearing there, unless he have lawful Warning; but if lawful Warning and Summons be given, and the Miner fail to come and appear, according to Custom, the first Time is 2 *d.* and so at every Court (if occasion ensue) is double the same, till it come to 5 *s.* 4 *d.* whereof 5 *s.* is due to the Lord of the Field, or Farmer, and 4 *d.* to the Steward: And in Case Twenty-four Miners be summoned on a Jury, for a Trial betwixt Party and Party, to appear at the *Barmoot-Court*; if there appear not 12 of them, whereby to have a full Jury, then all such as fail in appearing herein, shall be fined, as the Bar-master or Steward pleases, in any sum not exceeding 10 *s.* provided always, they have lawful Summons, and be able of Body to come.

ARTICLE

ARTICLE LI.

We say, that if any Groove, Shaft, or Meer of Ground be in Controversy, and the Grand-jury, or Twenty-four, be called to view that Shaft or Meer of Ground, or to do or perform any other Duty concerning the same, and thereupon make an Order, and give their Opinions under their Hands in Writing, concerning such Groove, Shaft, or Meers of Ground in Controversy: Then such Order, or Opinion, as the Grand-jury, or Twenty-four, or Part of them make, being above four, may and ought to be produced in the *Barmoot-Court* at the Trial, and there openly read, and shewed to the Jury, that they may take notice thereof as they think fit.

ARTICLE LII.

We say, that if the Grand-jury, or Twenty-four, for the Mine, or Part of them, be (by the Bar-master, or his Deputy) called to view any Work within Ground; or to do, or perform any other Office or Duty, concerning these, or any other Articles, for the Custom of the Mine; if any Person or Persons resist, or hinder them therein, every one so offending shall forfeit for every such Offence 5 *l.* the one Half to the Lord of the Field, or Farmer, and the other Half to the Bar-master, or Steward; and if any resist the Bar-master, or his Deputy, he may, if need be, call any Miners to assist him, and the Grand-jury, or Twenty-four, or part of them; and if any Miner neglect or refuse herein, he shall forfeit for every such Neglect 5 *s.* to the Lord of the Field, or Farmer.

ARTICLE LIII.

We say, that the Bar-master, or his Deputy, or the Steward, ought to levy and collect all Fines and Forfeitures, due by Custom of the Mine; and where any Person hath not Oar to discharge the same, and is not otherwise able, or willing to pay such Fines and Forfeiture; then the Bar-master, or his Deputy, shall (for every such Offence) punish every such Person in the Stocks, to sit there twelve Hours pining, with a Paper on his Back, shewing for what Offence he sits there; but in case the Bar-master, or his Deputy, or the Steward, do not henceforth levy and collect all Fines and Forfeitures, due by the Custom of the Mine, nor punish such Offenders in the Stocks, as are fit to be punished; they shall forfeit for every such Neglect 5s. to the Lord of the Field, or Farmer.

ARTICLE LIV.

We say, if any Miner or Miners, or any other Person or Persons, be possessed of a Meer or Meers of Ground, or Part or Parts thereof, and work it truly, according to the Custom of the Mine; if there be any Person or Persons that shall or will make Claim or Title to the same, or any Part thereof; that he or they shall come and make their Claims (either by themselves, or by some Agent employed by them) before the Bar-master, or his Deputy; and within six Months after the same shall be in Workmanship; and if denied of what he or they shall claim, he or they must arrest within fourteen Days after the said Claim

Claim and Denial, or else his or their Title shall be deemed unlawful, and to have no Plea for it in the *Barmoot-Court*.

ARTICLE LV.

We say, whereas we find by daily Experience, that great Abuses, and many Inconveniences do arise, by Persons taking Part on both Sides, and only putting in their *Pawns*, and will neither maintain with Plaintiff nor Defendant of their necessary Charges; and they so refusing to pay, poor Men are many Times utterly undone and overthrown. Whereupon we order and agree, (that where any Controversy shall happen about any Groove or Grooves, Meer or Meers of Ground in Question) where such Suit ariseth, if any Person or Persons claim any particular Part or Parts of a Meer of Ground in Question, where such Suits ariseth; if any Person or Persons make Claim on both Sides, and would only defend his or their Part or Parts, by putting in his or their Part or Parts of *Pawns* on both Sides. We say, that it shall not be sufficient for any Person or Persons to defend his or their Part or Parts by such Means only; but he or they must either take to the Plaintiff or Defendant, to defend his or their Part or Parts, according to the Custom of the Mine; that is to say, he shall pay his or their Part or Parts of Charges, as shall be needful to make the Truth appear, in trying of the Cause or Causes, as well as putting in their Part or Parts of the 4 s. 6 d. for the *Pawn* or *Pawns*; and Charges being lawfully demanded of such, before the Bar-master of the Liberty, and one or more of

the Grand-jury, or Twenty-four; if the Party or Parties of whom Expences in such Suits and Trials is demanded, as aforesaid, do not pay the same Charge within four Days after it is lawfully demanded; then such Party or Parties, refusing or neglecting to pay the same after such Demands, shall forfeit his or their Part or Parts to the Parties grieved, to be equally divided amongst them, according to their proportionable Parts.

ARTICLE LVI.

We do order and say, that if any Person that works for Wages at any Groove, or Grooves, Shaft or Shafts, Meer or Meers of Ground, within the said *Soak* and *Wapentake*, and shall have his or their Wages wrongfully detained or with-held from him or them, by the Owner or Owner's Servant, or Agents, at any of the said Grooves, Shaft or Shafts, Meer or Meers of Ground; that then, if such Person or Persons, from whom such Wages shall be due, or from his or their Servants or Agents employed to manage their Mines, do not well and truly pay such Wages as shall be due to any Workman or Servant, within ten Days after an Account given, and Demand made of such Person or Persons Servant or Agents; that then in such Case, the Workman or Servant who shall be behind in Arrear, and unpaid, as aforesaid, may arrest, where such Work was done, or elsewhere, within the said *Soak* and *Wapentake*, his or their Part or Parts of *Oar*, or other Material, where such Person or Persons Servant or Agent (doth not pay as aforesaid) are concerned, or have any

Part

Part or Parts thereof, and so bring it to Trial at the next *Barmoot-Court*; and if such Person or Persons, Servants or Agents, Defendant or Defendants shall be cast, and condemned by the Verdict of 12 Men; then such Defendant or Defendants shall pay all such Wages forthwith, which shall be given in Damage, and 10 s. over and besides, for and towards the Costs of such Workmen or Servants, Plaintiff or Plaintiffs, in the Recovery of such just Wages, if their Oar be sufficient under Arrest to defray the said Charge; but if not, and such Defendant or Defendants refuse and neglect still to pay such Wages and Charges, as aforesaid; then the Bar-master of the Liberty where the said Defendants have any Grooves, shall have power to levy the same by Distress and Sale of the Defendant or Defendants Oar, or Mineral Materials, if any; or otherwise, he shall deliver all his or their Grooves, or Parts thereof, to the Plaintiff, to work until the Cost and Damages be fully paid, with all Charges in working the same: And the Bar-master shall not neglect this present *Article*, on pain to forfeit (to the King, or his Farmer) 5 s. 4 d. and to the Party grieved 5 s. And if the Defendant or Defendants shall contemn or disobey this *Article*, or hinder the Fa-master in the Discharge of his Duty, that then every such Offender shall forfeit for every such Offence 20 s. to the King's Majesty, or to his Farmer.

ARTICLE LVII.

Also we order and say, that from henceforth, when any Person or Persons shall complain at any great *Barmoot-Court*, for want of Company

pany and Charges, that such Complainants shall have a just Bill of Charges (if such can be had) annexed to the Bill of Complaint, which the Twenty-four shall have Power to determine: Or, at least, he or they shall declare upon his or their Oaths to the Grand-jury, or Twenty four, the gross Sum or Sums of Money, at such Groove or Grooves where such Part-owners are complained against, for Want of Company and Charges, as the said Part-owners shall be behind and in Arrear; which Sum or Sums shall be set down in the Order or Verdict of the Grand-jury, or Twenty-four; and if such Sum or Sums be not paid into the respective Bar-master's Hands (for the Use of the said Complainants) within ten Days after Warning given them; then the Bar-master may and shall deliver Possession, according to the said Order: But if the Person or Persons complained against, or their Agents, be not resident within the *Stak* and *Wapentake* of *Wirksworth*, or if upon diligent Enquiry made by the Bar-master, within twenty Days after the said Order to him delivered, that such Person or Persons cannot be found to be resident, nor his Agents, as aforesaid; that then in such Case, the Bar-master may take with him one or more of the Grand-jury, or Twenty-four, and go to the Groove or Grooves, Meer or Meers of Ground, where such Company and Charges are wanting; and there in the Mineral Time of the Day, openly declare, That such Person or Persons shall come in, and keep Company, and pay such Charges, as is contained in the said Order, within ten Days after, or lose his or their
Part

Part or Parts. And if such Charges be not paid according to the said Order, then the Bar-master, or his Deputy, may, and shall deliver Possession, according to the said Order, to the said Complainants: And the Bar-master shall not neglect his Duty herein, on pain to forfeit 10 s. to the King, or his Farmer.

ARTICLE LVIII.

We say, that no Person or Persons shall let, hinder, or deny the Bar-master and Twenty-four, or any of them, by Firing, or any other Ways or Means whatsoever, from going into any of their Grooves, Shaft or Shafts, Meer or Meers of Ground, to view and see whether any Wrong or Trespass be committed between Party or Party: Nor for plumbing and dialling in any of their Grooves, Shafts, or Meers of Ground, for the End, and setting streight of Matters in Controversy, on pain of every one so offending to forfeit for every such Offence 40 s. of good and lawful *English* Money, whereof 20 to the King's Majesty, or his Farmer, and the other 20 to the Party wronged or grieved; provided always, that the Bar-master and Twenty-four, or any two or more of them, come at lawful and convenient Times of the Day.

ARTICLE LIX.

The Grand-jury or Twenty-four for the Body of the Mine, do order and say, that from henceforth, every Miner and Maintainer of Mines, within the *Soak* and *Wapentake* of *Wirksworth*, shall prefer their Bills of Complaint at every great *Barmoot-Court* against their Part-owner or Part-owners, Groove-fellow

fellow, or Groove-fellows, in open Court, during the Time of the Steward's sitting, and not after any Adjournment; to the End that every Person concerned, or against whom any Bill is preferred, may have legal Proceedings, in open Court, according to the Custom of the Mine.

BOOK II.

The Form of a Bill of Complaint, put up
at the Great *Barmoot-Court* held
at *Wirksworth*, April 12, 1681.

J Ohn Woodhave, and his Groove-Fellows,
complain themselves to this Court, against
William Holdfast and Robert Non-pay, or
any one that claims under them, or either of
them, for not coming in and keeping Company at
the Old Man's Groove, on the Cole-hills, in
the Pens Rake, being within the Liberty of
Wirksworth, and Jurisdiction of this Court;
and for not paying the Sum of 4l. which is
due for them to pay; being 40 s. a piece for
either of their eight Parts to pay; And there-
fore prays relief.

The Form of a Crofs Bill, at the same
Court.

At the Great *Barmoot-Court* held at *Wirk-
sworth*, for the Soak and Wapentake of
Wirksworth, April 12, 1681.

Whereas, John Woodhave, and his Groove-
Fellows, have complained themselves to this Court,
against William Holdfast, and Robert Non-
pay, or any that claims under them, or
either

either of them, for not coming in and keeping Company with them at the Old Man's Groove on the Cole-hills, being within the Liberty of Wirksworth, and jurisdiction of this Court, and for not paying the Sum of 4 l. which they say is due for them to pay, being 40 s. apiece for either of our eight parts: We the aforesaid William Holdfast and Robert Non-pay, do hereby declare to prove the Payment of the aforesaid 4 l. being 40 s. for either of our eight Parts: And therefore pray to be dismiss.

At the Great Barmoot-Court held at
Wirksworth, April, 12. 1681.

The Names of the Jurors, and their
Verdict upon the aforesaid Bill.

William Stone.	Robert Letslip.
Henry Stafford.	William Castby.
Adam Bell.	Adam Smoker.
Clement Clough.	Thomas Shepphard.
Thomas Twigg.	Anthony Long.
John Hill.	Richard Short.
Anthony Wood.	Gervis Standby.
William Ward.	John Hanger.
Robert Stand.	Abraham Woodwit.
William Winkat.	Samuel Wagstaffe.
Henry Neerheed.	Elias Pool.
Joseph Knowsnot.	Martin Spenceer.

We the said Jurors, being elected, sworn and charged, do (upon Our Oaths) order and say,
That William Holdfast, and Robert Non-pay, or any one that claims under them, or either of them, shall come in and keep Company with John Woodhave, and his Groove-Fellows; and
Ball

shall pay the sum of 4 l. being 40 s apiece for either of their eight Parts to pay, which they are behind and in Arrear, at the Old Man's Groove, on the Cole-hills, being within the Liberty of Wirftsworth and Jurisdiction of this Court, within ten Days after lawful Warning given, or Publication made, according to the Article, or lose their parts.

Then you must return the Cross-Bill
Ignoramus.

The Form a Bill made at the small Court-Barmoot, for tryal of Titles.

At the small Court-Barmoot held at
— the 13th Day of April, 1681.

Edward Wood, and his Groove-Fellows, complain themselves to this Court, against James Wilde, and his Groove-Fellows, for unjustly entering into, and detaining from the Complainants one Founder Meer of Ground in a Gross rake, discovered out of the great White Rake, within the Liberty of Crumford, and Jurisdiction, of this Court (on Crumford-Moor) and also one First Taker Meer of Ground Eastward, or a Possession for a First-Taker Meer; and for getting therein, and carrying away, One Thousand Loads of the Plaintiff's Lead Oar, and converting it to the Defendants own use, to the Plaintiff's Damage of a Thousand and Fifty Pounds; And thereupon they bring their Suit, and crave relief.

The Defendants appear and plead the
six Months Article in Bar.

Jurors	E. D.	A. B.	F. T.
Names	E. W.	R. C.	A. T.
	A. H.	J. H.	T. R.
	H. C.	T. P.	W. F.

Verdict. We the said Jurors being elected sworn and charged to say the Truth in the Premises, upon our Oaths say, That the Defendants are not guilty of entering into and detaining from the Complainants, one Founder-meer of Ground in a Cross-Rake, discovered out of the great White Rake, within the Liberty of *Crumford*, and Jurisdiction of this Court; (on *Crumford Moor*) nor for entering into one First taker meer Eastward, as in the Bill is set forth. Therefore (according to several Customs and Articles used within the said Soak and Wapentake) upon our Oaths do further say, That the Complainants shall pay 4s. for 12 Men's Dinners, &c.

The Form of a Bill put to the Twenty-four, when called to view a Mine in question.)

William Fainwood, and John Haveall, and their Groove Fellows to the Grand-jury, or Twenty-four, for the Soak and Wapentake of Wirksworth; being called to the Gang-Rake, on Middletown-moor, within the Liberty of Middletown *aforesaid*, the 16th of April 1681

You are desired to go down at the Hedge shaft, and so through the Drift, and down the Turn, and then through the Drift at the Turnfoot, and so through the King's half Meer, then through the hole at the Rither Point into *Bates* work, and so up his Turn and Shaft to the Day, and to give your
Opinions,

opinions, whether it be not all one and the same Vein.

Then as many as judge it to be one and the same Vein, write their Opinion, if they exceed 12.

Some EXAMPLES, of DIALLING.

HAying provided your self of a *Dial* in a square Box, or a long square Box, which is better; and also of a two foot Rule; and a string or Cord with a Plummet as the end; suppose you be desired, or (to try your own Skill) would know the exact depth of a *Hading Shaft* and *Turn*, and how far *rites* are driven in that Meer of Ground to an Inch. First cause some one to go down the Shaft, then let your Cord or String down after him as far as you can, till it touch somewhere on the side, observing the most convenient place at the *Stows*, where the String will go down deepest and not touch the sides, and where the Plummet touches the side, bid him make a mark at the end thereof; Then the String hanging there, apply the side of your Dial thereto, as near crossing the Rake as you can judge by the handing below, and observe what Point the Needle stands on, which here you may suppose to be 52. and this point you must keep for your square; then pull up the String, and measure it, and set the length thereof down in Rules and Inches, under which

the word *Depth*, as you may see in the Example following, which you may suppose here to be 24 Rules, and Inches 00; which when you have set down, and the point 52 directly over against it; then go down to the place where he made the mark in the Shaft, and because your Shaft haves, put one end of your Rule to the place where he made the mark, and lay the Rule cross into the Shaft; then apply your *Dial* to the edge of the Rule, and wave the *Dial* and Rule up and down together till you see the Needle stand upon 52, your square point; then from the most convenient place of your Rule (whether it be at the end, or in the middle, where the Cord will go down the deepest and not touch the sides) there hold the Cord, and where it touches the side at the end below, there bid him make a mark; ~~then (observing what Inches lies against at the~~ Rule, as here at 22) pull up the Cord, and measure the length thereof, from the Rule to the mark below; not forgetting to hold your finger fast upon the Cord, which you may suppose to be 16 Rules; which (because you are plumbing) must be set down under *Depth*; Then, having set down your point 52, and the 22 Inches in their respective places, as in the Example following appears, go down to the place where he made the last Mark; and putting one end of your Rule thereto, lay the other into the Shaft, and apply your *Dial* to the edge of the Rule, and wave them up and down together as you did before, till you see the Needle stand upon 52, the Rule and *Dial* lying close together, let down your Cord as far as you can, till the Plummet touch
the

the side below, holding the String at the middle or end of the Rule, or where you see it will go down deepest, and not hang on the sides; then bid him make a mark below, where the Plummet touches the side; which done, pull up the Cord and measure the Length, first observing at what Inches of the Rule you held it; and so set down your *Depth*, *Point*, and *Length* in their right places, which here you may suppose to be 26 Rules and 14 Inches, point 52; and the cross Length taken thereon, 1 Rule and two Inches: Then go down to the mark he last made, and putting one end of the Rule therein, lay the other cross, as before, and apply the side of the *Dial* to the edge of the Rule, and wave them up and down till the Needle stands on 52; then let down the String on the Shaft foot, and bid him make a mark below, observing that the String touches no where on the sides, betwixt you and the mark he makes at the Shaft foot; so observing what Inch the String lies at against the Rule, pull it up and measure it, how many Rules it is, which you may suppose here to be 28 Rules and 22 Inches, which set down, and the point 52, and also the number of Inches where the String lies upon the Rule, which here is 18 Inches; and so you have finished the Shaft: Then going down to the Shaft foot, hold the *Dial* where the Mark was made, and set the Needle upon 52; and if there be any occasion to take a short cross length, whereby to give you better liberty to take a long length in the drift; then take the short length, the Needle standing upon 52, apply the String parallel to the side

of the *Dial*; and having made a mark at the End of the short Length, measure how many Rules and Inches it is, (and set it down) which you may suppose here 1 Rule and 10 Inches: then set down the Point directly against it, by which you took that length as 52; which done, give him that is with you, the End of the String, and let him go back into the Drift as far as he can, till the String begins to touch somewhere on the Side of the Middle, and then holding one End of the String in the Mark you made, when you took the short Length; observe that the String touches nowhere betwixt him and you; then apply the Side of your *Dial* to the String, taking notice that the *Dial* and String lie streight one with another, and so take the point the Needle stands on, which here you may suppose to be 36; then let him that is at the other End, either make a Mark on the Side, or drop a Stone to the Sole of the Drift, as you find Occasion; which done, draw the String back, and measure it, and set the Length thereof down in Rules and Inches, which you may here suppose to be 22 Rules and 8 Inches, and overagainst it the Point 36: Then go to the Place where he dropt the Stone or made the Mark, and laying the Rule or String cross, one End being in the Mark, take a short Length [as you find Occasion] setting the Needle upon 52; which done, set down the Point, and this short Length overagainst it, which here you may suppose to be 10 Inches: having so done, and made a Mark, or dropt a Plum at the End of these 10 Inches, this short Length will give you Liberty to take a long Length forwards

forwards in the Drift : So let him take the String, and go as far backwards as he can 'till the String almost touches somewhere in the Middle on the Side ; then (holding one End in the Mark you last made, when you took the short length) stretch the String streight, and apply the Side of the *Dial* to the String, and take the Point the Needle standson, which here you may suppose to be 36 ; so set down the Point, and bid him make a Mark at the End ; then pull back the String and Measure it, setting down the length directly against the Point you last took, which you may here suppose to be 24 Rules and 14 Inches ; and that to reach to the Turn-head. So being now come to the Turn-head, you must fall to plummeting again.

Therefore set the Needle upon 52, your old Square, and if there be any need, to take a short length, whereby to give you liberty to plum the deeper in the Turn, then you must take it ; so bidding him go down the Turn, let the String down after him, and where it touches on the Side let him make a Mark ; you holding one End of your Rule in the Mark that was made at the Turn-head, lay the Edge of the Rule to the Side of the *Dial*, and wave them together till the Needle stands upon 52 ; then set down that short Length, which you may here suppose to be 8 Inches, and pull up the String and measure it ; which you may here suppose to be 28 Rules and 6 Inches ; set it down, and the Point 52 also ; which done, go down to the Mark he made ; and because the Turn fades, put one End of the Rule in the Mark,
and

and lay the other cross into the Turn ; so put the Side of the *Dial* to the Edge of the Rule, and wave them together, till the Needle stands upon 52 : Then let the String down to the Turn-foot ; if it will not touch the Sides betwixt the Turn-foot and you ; so holding the String at the End of the Rule, set down this short Length, which is 1 Rule, and the Point 52 ; and bidding him make a Mark at the Turn-foot, measure the Length, which you may here suppose to be 30 Rules and 2 Inches ; And so you have plummed the Turn.

If you have any further to Dial, observe to take your square point, where there is this Occasion ; for if you omit taking your Square you will lose yourself in the Exactness of the Grounds Length, sometimes making it more, and sometimes less then really it is, and so commit great Error, when you come to dial it above Ground : You must also take Care that you hold your Rule level, when you take your cross Lengths, and also your String when you take Lengths in Drifts ; and by that Means you will have the exact Depth : You must also observe that your Rule and String lie parallel with the Edge of your *Dial*, that is, equally at both Ends ; or else you will miss in taking the true Point. Under Ground the *Dial* is guided by the String ; but above Ground the String is guided by the *Dial*.

Example.

EXAMPLE.

Depth. Points. Length.

Ru.	Inch.		Ru.	Inch.
24.	00.	52.	00.	00.
16.	00.	52.	00.	22.
26.	14.	52.	01.	02.
28.	22.	52.	00.	18.
00.	00.	52.	01.	10.
00.	00.	36.	22.	08.
00.	00.	52.	00.	10.
00.	00.	36.	24.	14.
28.	06.	52.	00.	08.
30.	02.	52.	01.	00.

That is 152 Ru. 44 Inch.

And the Rule containing 2 Foot, it makes in all 307 Foot and 8 Inches for the Depth of the Shaft and Turn ; which by Reduction makes 51 Fathoms, 1 Foot and 8 Inches, for the true Depth of that Mine.

Example.

44 Inches make 3 Foot 8 Inches ; which set below the 304 ; and added makes $307\frac{8}{12}$.

add 152.
 152.

Sum in fingle

304. Foot.

$3\frac{8}{12}$. add.

307. Foot.

Now

Now, if you would know how much your Shaft and and Turn haded, you must add up the Lengths that stand against your Square-point 52. As for Example.

<i>Rules.</i>	<i>Inches.</i>
00	22.
01.	02.
00.	18.
01.	10.
00.	10.
00.	08.
01.	00.
<i>Rules</i> 03.	70. <i>Inches.</i>

Which by Reduction makes 11 Foot and 10 Inches ; and so much your Shaft and Turn hades. To know the exact Length you have driven in your Ground, without laying it forth above, you must add up the Rules and Inches that stands under the Word *Length*, against your by-points ; which in this Example is only *Rules* 22. and 8. *Inches.*
and 24. and 14.

That is, Rules 46. and 22 Inches.

Which by Reduction is 93 Foot and 10 Inches ; which makes 31 Yards 10 Inches you have driven ; but if you are to dial and lay it out above Ground, set the *Dial* upon the Point 52 ; and looking in your Note for 22 Inches, which was the first Length ; put one End of the Rule to the Place of the *Stows* where you held

held the String when you began to plum the Shaft ; the Rule lying to the Side of the *Dial*, and the Needle standing upon 52, make a Mark at 22 Inches upon the Ground ; and so you have done the first Point: And in like Manner you must do all the Rest, if you go over these Points singly, one by one ; but because here is several square Points before you come to any by-point, that goes as the Rake goes ; therefore you may take all these square Points together, first adding their Lengths up, and knowing how many Rules and Inches they make : As for Example.

	<i>Ru.</i>	<i>Inch.</i>
<i>The first Point is</i>	00.	22.
<i>The second Point is</i>	01.	02.
<i>The third Point is</i>	00.	18.
<i>The fourth Point is</i>	01.	10.
<i>Sum is</i>	2.	52.

Which by Reduction makes 4 Rules, and 4 Inches ; that is, 3 Yards wanting 8 Inches, and so much your Shaft hades ; therefore if you first measure out so much upon your Cord, and hold one End at the same Place on the *Stows*, and give him the other End to go forwards with ; then the Side of the *Dial* lying streight with the String, and the Needle standing upon 52, bid him make a Mark there ; and so you have taken all the 4 Points together, and found the Mark above Ground, which he made at the Shaft-foot : Then go to the Mark he made, and looking in your Note, what your

N

next

next Length is, (which is 22 Rule and 8 Inches) measuring out so much upon your Cord ; let him go forwards with one End, and Cause some one to hold the other End in the Mark he last made ; then look in your Note for your Point overagainst that Length, which is 36 ; so setting the Needle upon 36, let him that has the Plummet-end bring the Cord to the Side of the *Dial*, you standing some distance from him that holds the other End in the Mark: Then (the Cord lying exactly even with the Side of the *Dial*, and the Needle standing upon 36) bid him make a Mark at the End of the Plummet ; and so you have done that Length ; go then to your last Mark and put one End of your Rule in it, and set the Needle upon 52, laying the Edge of the Rule to the *Dial*, the Length being but 10 Inches, make a Mark there ; then look in your Note for your next Lengths which is 24 Rules and 14 Inches ; which measure out, and let him go on with the String, causing the other End to be held in the last Mark ; and setting the Needle upon 36, the Point over-against that Length, bid him wave the Cord up and down till it lies exactly streight with the Side of the *Dial* ; then bid him make a Mark ; so you have done that Length. Lastly, because the other 2 Lengths are both to be taken upon one Point, and there being no other by-point betwixt them, therefore you may add the Lengths together (and take them at once) which is 1 Rule and 8 Inches, the Needle standing upon 52 ; the End hereof is the Place above Ground directly over the Mark you made at the Turn-foot.

Now

Now, to know whether you have dialled this exactly or no (without going over it again) first add all your square Lengths together : as for Example.

<i>Ru.</i>	<i>Inch.</i>
00.	22.
01.	02.
00.	18.
01.	10.
00.	10.
00.	08.
01.	00.
<i>Sum is</i> 5.	22.

Which converted into Feet makes 11 Foot 10 Inches ; and so much your Shaft and Turnhades and declines from the Place you first begun to plum at the *Stows* : Then add up the Lengths you took Rake-ways, which was only 22. *Ru.* 08. *Inch.*

and 24.	14.
46.	22.

Which by Reduction is 93 Foot and 10 Inches, or 31 Yards and 10 Inches : so taking your Rule and Measuring out the 46 Rules and 22 Inches ; give him the Plummet-end to go Rake-ways, causing some one to hold the other End at the Place on the *Stows* where you first began to plum ; then go you to the Middle of the String, and setting the Needle upon 36, bid him wave it up and down, till

N 2

you

you see the String lie exactly streight with the Side of the *Dial*, then bid him make a Mark at the End: go to this Mark, and measure out your square Length, which in all was 5 Rules and 22 Inches; give him the End, holding the other End in the Mark, set the Needle upon 52, bid him wave the string up and down, till it lie parrallel with the Box: Then bid him make a Mark. And if this Mark hit the Mark you made when you Dialled it before, you have done the Work exactly, or else you have committed some Error.

Note, This Rule always holds true, when you take square Lengths, and your Lengths forward, Rake-ways, or any ways, by one point: As here you took by the Point 36.

How to plum Shafts and Turns that bade, and beat into the End.

First, let down your Cord as far as you can, holding it at the most convenient Place on the *Stews*, where it will go down deepest; and where the end touches below bid him make a Mark: Then apply your *Dial* to the side of the Cord, (whilst it hangs there) and take that Point you judge to be the nearest crossing the Rake for your square Point, which here you may suppose to be 48; set the Point down, pull up the String and measure it, which suppose here to be 26 Rules and 8 Inches; set them down: Then go down to the Mark he made, put one end of the Rule therein, laying the other

other cross into the Shaft, apply the *Dial* to the edge of the Rule, the Needle standing upon 48, let down the Cord, (which by reason that the Shaft beats much one way, the Plummet will fall upon the end) and where it touches the end bid him make a Mark, observing what Inches of the Rule you hold the String at; which suppose here to be 18; set them down, and the Point 48 also; then go down to the Mark he made at the end of the Shaft, and putting one end of your Rule or String (whether you find more convenient) in that Mark, lay out the other end towards the other end of the Shaft, and take the nearest square Point you can to 48; which here suppose to be 32; make a Mark at the end of the String, in the other end of the Shaft, if you take it quite through; but if you take it half way by the Rule, then perhaps the Rule may touch the lying side, and then you must make a Mark there, the Needle standing upon 32, and set down the length taken upon that Point; and so afterwards take a cross length from that Mark upon your square 48; but if you take it quite through the Shaft, to give more Liberty to plum deeper the next time; then measuring it, set down the Length, and the point 32 over-against it, which here you may suppose to be 2 Rules and 8 Inches; which done, hold one end of the String in that Mark you made in the end of the Shaft, and let down the Cord as far as you can, till it either touch the side or the end of the Shaft; which here you may suppose to touch both end and side in the corner of the Shaft: bid him make a Mark there:

N 3.

Then

Then pull up the Cord, and measuring it, set it down under *Depth*, which you may suppose to be 8 Rules and 10 Inches: And here you are to take no Point, this being only a Plum: Then go down to the Mark, and put one end of the Rule therein, and lay the other against the *Wough*, lengthways of the Shaft, and apply the *Dial* to the side of the Rule, the Needle standing upon 52, make a Mark at the end of your Rule, or where you see most convenient; so counting the Inches, set them down and the Point 32, which here suppose to be 23 Inches: But if it chance, when your Rule lies to the *Wough*, you cannot take the Point 32 exactly; In such case, put the end of the Rule 3 or 4 Inches, more or less as you see convenient, towards the hanging side, but be sure it be level with the same Mark, and then set down so many Inches for a length as you judge it to be, and over-against the square Point 48: Or if it happen that the *Wough* flies back, so that the Rule needs not touch it, yet keep the Rule and *Dial* together, the Needle standing upon 32, set down that length you think most convenient to take, and then fall to plumbing again: And if your Plummet falls upon the end of the Shaft, or upon both ends and side as before, yet take your length upon the Point 32, by help of either of those ways you last took it; that is to say, by shifting your Rule or String something nearer the hanging side, taking care to set down those Inches you so allow against your square Point: But if it falls upon the side, and the Shaft hath left off under-beating, and goes streight,

only

only hades, then lay your Rule cross into the Shaft, and take your length upon the square Point 48, till you have finished plumbing the Shaft: So by observing these Directions well you may exactly Plum and measure to an Inch, any Shafts, Turns, Lobs or Stumps, that either hade, or hade and underbeat.

The Table of the foregoing Operation.

Depth.		Points.		Length.	
Ru.	Inch.	Ru.	Inch.	Ru.	Inch.
26	08	48	00	00	00
12	10	48	00	00	18
00	00	32	02	00	08
08	10	00	00	00	00
00	00	32	00	00	23

Sum 46 Ru. 28 Inch.

Which converted into Feet makes 94 Foot and 4 Inches; for you must observe, that the 28 Inches, is equal to 1 Rule and 4 Inches, or 2 Foot 4 Inches: So if you divide 94 Foot and 4 Inches by 6, the Number of Feet in a Fathom, you will find the Shaft to be 15 Fathoms, 4 Foot and 4 Inches deep: Now if you would know how much the Shaft hades and under-beats, and would find the Place above-ground where you made the Mark last below; First, add the Lengths together you took upon your square Point 48; which here was only 18 Inches: Then putting one end of the Rule to that Place of the *Stows* where you first

first began to plum, lay the *Dial* to the Side of the Rule, the Needle standing upon 48, make a Mark there: Then add together the Lengths you took upon the Point 32, which makes 3 Rules and 7 Inches; measure out so much, holding one End in the last Mark, let him go forwards with the other, set the Needle upon 32, the String lying streight with the Side of the *Dial*, bid him make a Mark there, and this is the exact Place above-ground right over that where you made the Mark last below.

How to plum and dial in an open Rake, where there is many cross Drifts and Turnings, and afterwards to square the same above Ground.

FIRST plum the Shaft, Turn, Lob and Stumps if there be any, by the *Directions* afore-delivered, chusing that Point for your Square which you judge goes nearest cross to Rake or Pipe; which suppose here to be 28; and take all your cross Lengths upon that Point, till such Time as you have done plumbing, unless it happen that your Plummet falls upon the End of the Shaft, or Turn, as you plum; If so, then take a new Square to this Square of 28, as you did in the last Example before, or the nearest it you can; setting down the Length and Points in order: Now suppose you come to take a Length forwards into the Drift at the Shaft-foot, having first made a Mark there where the Plum fell, let a Boy hold one End of the String therein, and bid

bid another Man take the Plummet, and go as far back into the Drift as he can, till the Plum he hath in his Hand touches the Side; and stretching the String streight, observe that it touches no where betwixt that End he holds in the Mark, and the Plummet the other Man hath in his Hand, (if it touches the Side bid him come nearer) then apply the *Dial* to the Side of the String, and when the String and *Dial* lie exactly straight together, take the Point the Needle stands on, which suppose here to be 44: Set down the Point, bid him make a Mark at the Plummet: Then pull back the String and measure it; which suppose here to be 12 Rules and 14 Inches: Then go to the Mark he made, hold one End of the String in it, bid him go back into the Drift with the Plummet as far as he can, till the middle of the String begins to touch the Side; then stretching the String straight, observe that it touches no where betwixt them that hold it, apply the *Dial* to the Side of it, and take the Point the Needle stands on, which here suppose to be 50; set it down, bidding him make a Mark at the Plummet; pull back the String and measure it, which suppose here to be 8 Rules and 6 Inches; which set down over-against the Point: Then go to the last Mark he made, hold one End of the String therein, bid the other go back with the Plum as far as he can, stretching the String straight, observe that it touches no where on the Side betwixt them that hold it; apply the Side of your *Dial* parallel to the String, and take the Point the Needle stands on, which suppose here to be

48; set it down, bid him make a Mark at the End; pull back the String and measure it, which suppose here to be 14 Rules and 8 Inches; then go to that Mark, and laying the String out as before directed, take the Point there, which suppose to be 52; set it down, and making a Mark at the End, let this be the Fore-field of your Work: Pull back the String and measure it, which suppose to be 16 Rules and 10 Inches: Then go up to the Day, and having gone over the Lengths and Points you took in plumbing the Shaft, and found the Mark above Ground you made at the Shaft-foot, (which you may do by the Rules and Directions already delivered,) measure out your first Length, 12 Rules and 14 Inches, hold one End of the String in the Mark, bid the other Man go forwards with the Plummet, then do you set the Needle upon 44, (and bid him wave the String to and fro, till it lies exactly streight with the Side of the Dial,) the Needle standing upon that Point, bid him make a Mark there; and so you have done your first Point; and in like Manner you must do all the rest following, 'till you find the Place above Ground right over the Mark you made at the *Fore-field* below; which done, make a Mark, and drive down a *Stake*. Now if you would know how far you are driven in your Meer, you must square the Ground above; therefore tie one End of your Cord to this *Stake*, and bid him go cross with the other End, 10, 20, or 30 Yards, more or less, as you think good; set the Needle upon 28, which was the Square you took when you first began to plum
the

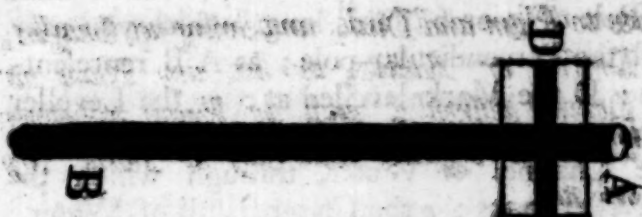
the Shaft, and do you stand in the Middle (betwixt him that holds the String, and the *Stake*) with the Dial, bid him move the String to and fro, or do you shift, if you see Cause, 'till the String lies exactly streight, and equally even with the side of the Dial; the Needle being precisely upon 28, bid him make a Mark at the End, drive down a *Stake* there, and pulling the String streight, fasten it to the *Stake* and leave it: Then come back to the Shaft, having another String ready, put one End to that Place of the *Stows* from which you first began to plum, set your Needle upon that Point, which is exactly square to that Square you took when you first began to plum the Shaft, which was 28; therefore the Point that squares it is 44: Then let him go forwards with the String upon that Point, 'till the String he hath in his Hand cross the String you fastened betwixt the *Stakes*, go you into the Middle, and apply the Dial to the Side of the String, bid him move it up and down 'till the Needle stands exactly upon 44; then bid him make a Mark where the Strings cross one another and drive down a *Stake* there; so the Distance measured from this *Stake* to the *Stows* is the true Length of your Ground driven.

How

How to Plum and Dial, and bring up Sougbs, Drifts, or Addits, to bit any Place or Depth desired; and to know whether a Sougb begun, will lay a Mine dry or nat.

HAVING first plumb'd your Shaft, Turn, Lobs and Sumps by the Rules afore-delivered, and knowing the Depth thereof: Because few or any Miners understand a *Quadrant*, the Instrument for this Purpose may be like the following, viz. A Water Stand, with one or more Channels; which the Miner may make himself, upon an old seasoned *Joyce*, cutting a Mortels therein a Yard long, or more, as his own Discretion directs, plain-
ing the same very well and even.

Havig



Having the Instrument ready, and a Staff or Pole of 5 or 6 Yards long, which you may call the Perpendicular-pole; as A B representeth: D the Mark levelled at: *m* the Leveller looking over the Channel: *a* the Hole above the Channel of Water, through which the Leveller looks: *e* the Channel full of Water: *o* the Pin at the End of the Channel: *n* a Piece of Wood with three Iron-forks at the End, to stick in the Ground: L a Board set up cross over the Channel, having a little slit under it, as at *a*: E F the Levelling-Line.

Suppose you be called to Level a Piece of Ground, to know whether it will lay dry a Mine (by a Sough) that is to be began in any Place appointed.

First view over the Ground, then erect your Instrument at the Mine, and cause some one to take the Pole, and to go as far towards the Place where you intended to begin your Sough, as the Length of your Pole will admit; then see that the Water stands even in the Channel: Look through the Slit at *a*, and bid him shift the Pole to and fro, 'till you see the Pin at *o*, interpose your Eye and the Mark you level at, as D: which done, bid him make a Mark at the Foot of the Pole; and shift your Instrument thither, and erect it there, setting down the Length of your Pole in Yards and Inches: Then do as you did before, 'till you have finished the Whole, and come to the Place where you intended to begin your Sough: Then reducing your Poles into Fathoms, compare them with the Depth of your Mine,

Mine, and thus you may know whether it will lay it dry or no.

Naturam ubiq; compendium amare :

Sensibus hic imis (res non est parva) repono.

Ingraft these Precepts deep within your Senses,
The Matter's good, and got by small Expence.

From my Lodgings near
Apothecaries Hall in Black
Fryars, London, Feb. 8,
1689.

E I N I S

The last Operation in Dialling.

<i>Depth.</i>		<i>Points.</i>	<i>Length.</i>	
<i>Ru</i>	<i>Inch.</i>		<i>Ru</i>	<i>Inch.</i>
00	00	28	00	00
00	00	44	12	14
00	00	50	08	06
00	00	48	14	08
00	00	52	16	10

A N
EXPLANATION
OF THE
MINERS
TERMS of ART

Used in this

B O O K.

B*Ar-master*, is he which keepeth the Gage or Dish to measure all Miners Oar, he or his Servant being present when measured.

Brazen-Dish, is the Standard by which the other Dishes are gaged, and is kept in the King's Hall.

Cavers, are any poor People that go about the Mines to beg or steal Oar from the Miners.

Goes, are little Houses which the Miners make over their Mines to lay the Oar in.

Cope, is 6*d.* for every Load of Oar, nine Dishes making one Load.

Crosses,

Crosses, are two Nicks cut on the Superficies of the Earth, thus  which the *Miners* make when they take the Ground to dig for Oar; This Cross gives the *Miners* three Days Liberty to make and set on *Stows*: As many of these Crosses as the *Miner* makes, so many Meers of Ground he may have in that Vein, if he set on *Stows* within three Days after the making his Cross or Crosses; but if he make but one Cross, and a Stander by makes the second, and a Stranger makes the third, every one is served with the next Meer, according as they have first or last, sooner or later made their Cross or Crosses upon the Ground.

Dish, is a Trough made of Wood, about 28 Inches long, 4 Inches deep and 6 Inches wide; by which all *Miners* measure their Oar: If any be taken selling their Oar, not first measuring it by the Bar-master's Dish, and paying the King's Duties, the *Miners* incur that Forfeiture which the 17th Article has imposed upon them.

Drift, is a Passage thus  cut out under the Earth betwixt Shaft and Shaft, or Turn and Turn, or a Passage or Way wrought under the Earth to the End of a Meer of Ground or Part of a Meer.

Farmer, is the Lord of the Field; or one that farms the Lot and Cope of the King.

Fodder of Lead at the Mines contains Twenty-two hundred and a half weight, though in *London* but Twenty hundred Weight.

Forestd.

Foreſtid Oar, is Oar that is gotten out of Earth and Dirt that hath been waſhed and Oar taken from it before.

Forfield is the furtheſt Place that a Man has wrought in his Ground; or the End of a Meer above Ground.

Groove, is the Shaft or Pit ſunk into the Earth; they are ſometimes ſunk in the Vein and ſometimes out.

Hack, is a Tool that *Miners* uſe like a Mattock.

Hade, is where any Shaft or Turn goes deſcending like the Side of a Houſe, or like the Deſcent of a ſteep Hill, then it is ſaid to hade.

Load, is nine Diſhes of Oar; each Diſh being about half a hundred Weight.

Lobs, are Steps that aſcend or deſcend within the Mines, as Stairs up to and down from a Chamber.

Lot, is the 13th Diſh, Measure or Part of the *Miners* Oar, which the Bar-maſter takes up for the King or the Farmer.

Meer, contains Twenty-nine Yards in length in any Vein.

Meer-stake is a Pin of Wood drove into the Superficies of the Earth, to ſhew the Extent or End of a Meer of Ground.

Old Works, are ſuch that are either fallen in or ſtand unwrought.

Pipe, is where the Oar runs forwards endways in a Hole, and doth not ſink downwards or in a Vein.

Pee, is where two Veins meet and croſs one another thus † the Place where they meet is called the *Pee*.

Poſſeſſion

Possession, is the right to a Meer of Ground, which *Miners* enjoy, by having *Stows* upon that Ground; and it is taken generally for the *Stows* themselves; for it is the *Stows* that give Possession.

Pawn, is a Pledge of Money put into the Bar-master's Hand at the Time when the Plaintiff causes the Bar-master to arrest the Mine.

Pick, is a Tool the *Miners* use to cut down the Cliffs and Rocks of Stone to make Passages in the Earth.

Rither, is a Stone or thin Cliff that lies in the Vein; the Oar sometimes runs on both Sides it; sometimes this *Rither* is so thick, it parts the Vein, and makes one Vein two.

Quarter-Cord, is seven Yards and a Quarter, which the *Miner* hath cross ways of his Vein on either Side; for Liberty to lay his Earth, Stones, and Rubbish on, and to wash and dress up his Oar.

Rake, is the same with a Vein.

Shaft, is the same with a Groove or Pit; they are sunk some ten, some twenty Fathoms deep into the Earth, more or less.

Stows, are seven Pieces of Wood (set upon the Superficies of the Earth) fastened with Pins of Wood together; two are called *Soul-trees*; two *Stow-blades*, two *Hang-benches* and a *Spindle*: These *Stows* give a *Miner*, or any Person that owns them, as good Right to a Meer or Meers of Ground, (so that every Meer have a Pair of *Stows* set on them) as a Deed of Conveyance doth to any Purchaser.

Stool,

Stool, is where the *Miners* leave digging deeper, and work in the Ends forwards; the End before you is called the *Stool*.

Spindle, is a Piece of Wood fastened into either *Stow-blade*.

Smytham, is Lead Oar stamp'd and pounded down, like Powder or Sand, to cleanse the Stones and Earth from the Oar.

Sough, is also called an *Addit*; it is a Passage like a Vault cut out under the Earth, to drain the Water from the Mines.

Smelting house, is a House where they run and melt the Oar into Lead; one of these will run a Ton in ten or twelve Hours: A Fodder is their usual Day's Work; that is, Twenty-two hundred and an half weight.

Sumps, are Holes sunk in *Drifts* to the Depth of two or three Yards, more or less.

Twenty-four Men, they are Twenty-four Men chosen every half Year to redress the Grievances of the *Mines* and *Miners*; but every Man generally serves his Year when chosen.

Next Taker, is he that makes the next Cross, or he that hath the next Meer in Possession.

Turn, is a Pit sunk in some Part of a Drift; If the *Mine* be deep, there is many of these *Turns* one below another.

Vein, is that which is bounded with *Woughs*, and contains Oar, Spar, Cauck, Clay, Chirt, Croil, Brown-hen, Pitcher-chirt, Gur, which the Philosophers calls the Mother of Metals, and Soil of all Colours sometimes. When it bears Oar it is called a quick *Vein*, when no Oar a dead *Vein*.

Woughs,

Woughs, are the Walls or Sides sometimes of hard Stone, and sometimes soft; when soft, then the *Miners* say they are rotten: These are the Bounds of an Entry. Betwixt them all Sorts of Earth, Stones and Oar lieth, or, as Philosophers say, groweth.

The End of the Explanation,

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